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AERONAUTICAL ENGINEERING

A SPECIAL BIBLIOGRAPHY

WITH INDEXES

Supplement 3

MARCH 1971

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PREVIOUS BIBLIOGRAPHIES IN THIS SERIES

<i>Document</i>	<i>Date</i>	<i>Coverage</i>
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AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 3

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in February 1971 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*



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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering.

This supplement to *Aeronautical Engineering—A Special Bibliography* (NASA SP-7037) lists 454 reports, journal articles, and other documents originally announced in February 1971 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. For previous bibliographies in this series, see inside of front cover.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries* in that order. The citations and abstracts are reproduced exactly as they appeared originally in *IAA* or *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

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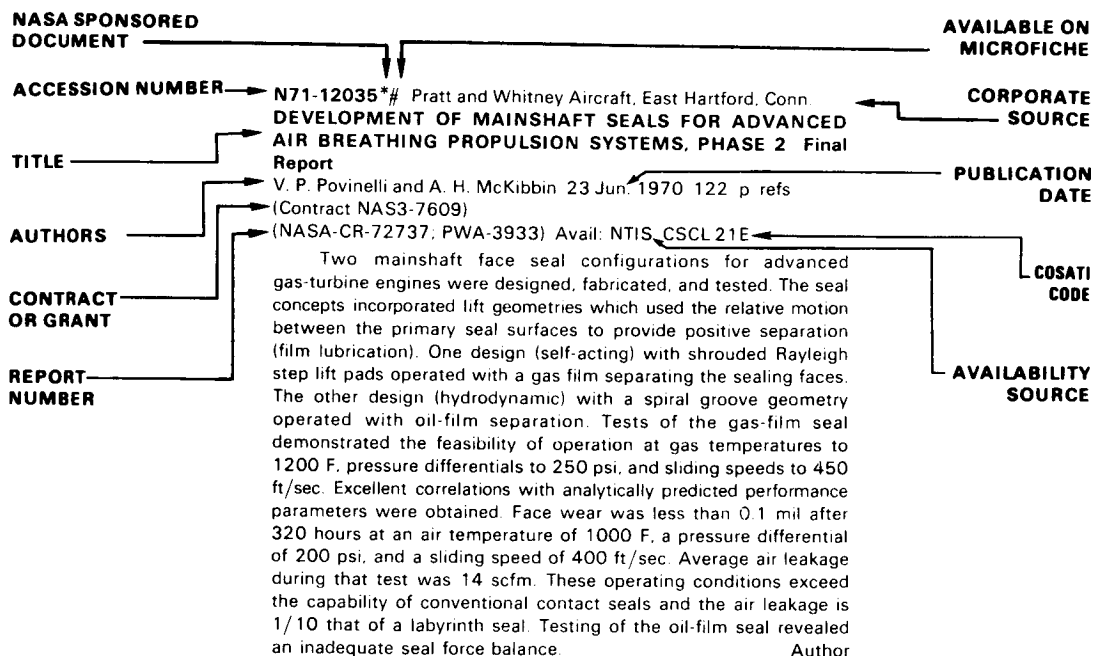
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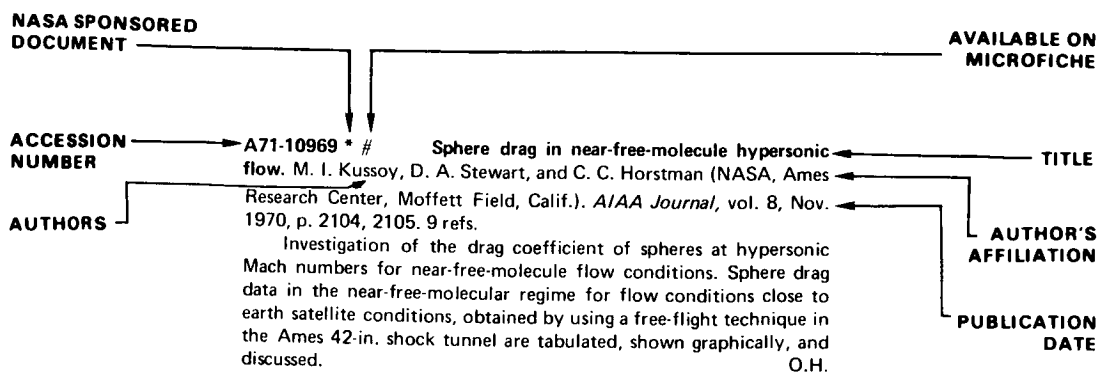
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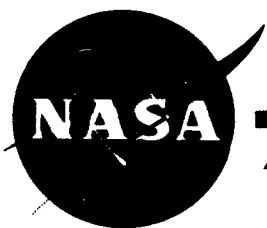
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AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 3)

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IAA ENTRIES

A71-12961 **Symposium on Air Accident Investigation and Litigation, Dallas, Tex., March 18-20, 1970, Proceedings.** *Journal of Air Law and Commerce*, vol. 36, Summer 1970, 195 p.

Contents:

The management systems approach to airport planning - Identifying and overcoming restraints. T. Sullivan, p. 387-393.

Procedure and conduct during on-site investigation of aviation accidents. C. O. Miller and W. L. Halnon (U.S. Department of Transportation, Washington, D.C.), p. 394-400.

Aircraft accident hearing. F. L. Puls (U.S. Department of Transportation, Washington, D.C.), p. 401-408, 13 refs.

Military investigations and reports of aircraft accident. C. Burton (USAF, Norton AFB, Calif.), p. 409-413.

U.S. air carrier accident investigation procedures. W. C. Hill (Eastern Airlines, Inc., Miami, Fla.), p. 414-420.

Limitation of liability by treaty and statute. G. N. Tompkins, Jr., p. 421-451, 63 refs.

Use of long interrogatories in aviation cases. N. Good, p. 452-466, 21 refs.

Limitations on liability in aircraft crash cases - Some reflections on aviation litigation trends and inequality. L. S. Kriendler, p. 467-474, 51 refs.

Panel - Voice recorder and flight recorder, p. 475-485.

Discussion - Session Two, p. 486-488.

Accident reconstruction and the use of experts. M. Foreman, p. 489-496, 11 refs.

Trial procedure - A composition analyzing some of the elements. J. L. Hill, p. 497-508, 14 refs.

Defendant counsel's considerations in air accident litigation. E. Jericho, p. 509-513.

Current trends in aviation product liability law. W. E. Maloney, p. 514-549, 229 refs.

The Tydings bill. A. L. Sanders, p. 550-557.

Panel discussion, p. 558-569.

A71-12962 **The management systems approach to airport planning - Identifying and overcoming restraints.** Tom Sullivan. (*Symposium on Air Accident Investigation and Litigation, Dallas, Tex., Mar. 18-20, 1970.*) *Journal of Air Law and Commerce*, vol. 36, Summer 1970, p. 387-393.

Consideration of the management systems approach to airport

planning, which implies an orderly arrangement of all elements into one total package. The elements are broken down into easily identifiable parts which are then worked with until every possible contingency has been examined. Attention is given, in turn, to the airspace over and around the airport site, the number and design of runways, the taxiway system, the apron areas, the terminal buildings, the parking lots, and the roadways and highways. F.R.L.

A71-12963 **Procedure and conduct during on-site investigation of aviation accidents.** C. O. Miller and W. L. Halnon (U.S. Department of Transportation, Bureau of Aviation Safety, Washington, D.C.). (*Symposium on Air Accident Investigation and Litigation, Dallas, Tex., Mar. 18-20, 1970.*) *Journal of Air Law and Commerce*, vol. 36, Summer 1970, p. 394-400.

In-depth examination of the on-site phase of aviation accident investigation and prevention. The investigation of an aviation accident, especially one of major proportions, is a complex, sometimes dangerous operation which takes place in an emotion-charged atmosphere. The procedures followed by the National Transportation Safety Board are outlined in some detail. It is considered that they have proven themselves to the point that most other countries follow them, at least in principle. F.R.L.

A71-12964 **Aircraft accident hearings.** Fritz L. Puls (U.S. Department of Transportation, National Transportation Safety Board, Washington, D.C.). (*Symposium on Air Accident Investigation and Litigation, Dallas, Tex., Mar. 18-20, 1970.*) *Journal of Air Law and Commerce*, vol. 36, Summer 1970, p. 401-408, 13 refs.

Discussion of aircraft accident hearings which, like the field investigation of a major accident, constitutes one phase of the total accident inquiry process. Its objective is to discover the facts, determine the cause, and ascertain measures to prevent similar accidents. The public hearing process used by the National Transportation Safety Board is outlined in detail. F.R.L.

A71-12965 **U.S. air carrier accident investigation procedures.** Walter C. Hill (Eastern Airlines, Inc., Miami, Fla.). (*Symposium on Air Accident Investigation and Litigation, Dallas, Tex., Mar. 18-20, 1970.*) *Journal of Air Law and Commerce*, vol. 36, Summer 1970, p. 414-420.

Outline of accident investigation procedures based in general on the policies and practices of Eastern Air Lines. Air carrier accident investigation procedures derive from a number of corporate concerns and obligations. Attention is given to the elements of procedure, as well as to the functions of individuals and groups, notifications, company field organization, and organization of the investigation itself. F.R.L.

A71-12966 **Limitation of liability by treaty and statute.** George N. Tompkins, Jr. (*Symposium on Air Accident Investigation*

and Litigation, Dallas, Tex., Mar. 18-20, 1970.) *Journal of Air Law and Commerce*, vol. 36, Summer 1970, p. 421-451, 63 refs.

Consideration of limitation of liability by treaty and statute, a subject which has become timely since the advent of the Boeing 747. Major attention is given to the liability for personal injury to or death of passengers. The subjects discussed are (1) the present statutory and treaty provisions which serve to limit liability in aviation accidents, (2) recent efforts to bring about a more permanent revision of the Warsaw Convention system of liability and limitation on recoverable damages, and (3) an examination of the question of whether there is any justification for the United States to remain or become a party to any international agreement which is designed to limit liability in aviation accidents. It is suggested that if there is to be any system of limitation of liability by treaty to which the U.S. is a party, the limitations should apply to both domestic and international air transportation. F.R.L.

A71-12967 Use of long interrogatories in aviation cases. Ned Good. (*Symposium on Air Accident Investigation and Litigation, Dallas, Tex., Mar. 18-20, 1970.*) *Journal of Air Law and Commerce*, vol. 36, Summer 1970, p. 452-466, 21 refs.

Use of long interrogatories as a means of making exhaustive, detailed analysis of the three cardinal factors in aviation accident cases: man, machine, and environment. Interrogatories have some distinct advantages over oral depositions, and the fact that they are long is not a ground for objection. Meaningful discovery requires using interrogatories early. Comments are made on many legal aspects of interrogatories, and advice is given on how to prepare them. F.R.L.

A71-12968 Limitations on liability in aircraft crash cases - Some reflections on aviation litigation trends and inequality. Lee S. Kriendler. (*Symposium on Air Accident Investigation and Litigation, Dallas, Tex., Mar. 18-20, 1970.*) *Journal of Air Law and Commerce*, vol. 36, Summer 1970, p. 467-474, 51 refs.

Advocacy of the proposition that the principle of limitations on liability in air crash litigation is unsound. The inequality of international limitations is discussed extensively, and it is considered that there is no longer just a 'plaintiff's view.' The principles of 'significant relationship' and artificial limitations in domestic crash cases are studied. F.R.L.

A71-12969 Accident reconstruction and the use of experts. Marshall Foreman. (*Symposium on Air Accident Investigation and Litigation, Dallas, Tex., Mar. 18-20, 1970.*) *Journal of Air Law and Commerce*, vol. 36, Summer 1970, p. 489-496, 11 refs.

Discussion of the recommended procedures to be used by lawyers in reconstructing aircraft accidents. The usual practice is to prove the facts established by the National Transportation Safety Board (NTSB). Expert testimony may be required to establish liability or defenses. Knowledge of what to look for, how to ask for it, and how to turn it into admissible evidence is required. Many case histories are presented. F.R.L.

A71-12970 Trial procedure - A composition analyzing some of the elements. John L. Hill. (*Symposium on Air Accident Investigation and Litigation, Dallas, Tex., Mar. 18-20, 1970.*) *Journal of Air Law and Commerce*, vol. 36, Summer 1970, p. 497-508, 14 refs.

Analysis of some of the elements involved in effective trial procedure for recovery of damages in aircraft accident cases. It is considered that the present judicial machinery, both state and federal, generally functions well in handling the problem. Aspects of pleadings, discovery, depositions, settlement negotiations, and jury summation are discussed. Various case histories are cited and analyzed. F.R.L.

A71-12971 Current trends in aviation product liability law. Wallace E. Maloney. (*Symposium on Air Accident Investigation and Litigation, Dallas, Tex., Mar. 18-20, 1970.*) *Journal of Air Law and Commerce*, vol. 36, Summer 1970, p. 514-549, 229 refs.

Discussion of aviation product liability law, the interpretation and application of which requires attorneys who are soundly based in engineering principles and can effectively bridge the gap between technical terminology and the vernacular for the jury. The development of products liability law and warranty law is discussed, as well as current trends in aviation products reliability. The successful defense of a liability case is outlined, and many typical cases are analyzed. It is suggested that good quality control methods can be easily worked up and kept at a minimum of expense and bother, and with a maximum of effectiveness in the eventual product liability suit. F.R.L.

A71-13016 Acrostar - Development, construction and flight tests (Acrostar - Entwicklung, Bau und Flugerprobung). Arnold Wagner (Swissair AG, Kloten, Switzerland). *Deutscher Aerokurier*, vol. 14, Nov. 1970, p. 779-783. In German.

Discussion of the history of the Acrostar, a unique aircraft which was developed as an aircraft of superior qualities for aerobatic contests. The specifications for the Acrostar are considered, and the various components of the aircraft are described. The performance obtainable with the Acrostar is compared with data from other aerobatic aircraft. Details of the design and the construction are given, and the results of the flight tests conducted are examined. G.R.

A71-13017 Elementary aerodynamics as a contribution to the prevention of accidents (Elementare Aerodynamik als Beitrag zur Unfallverhütung). Hans U. Ohi (Bundesanstalt für Flugsicherung, Frankfurt am Main, West Germany). *Deutscher Aerokurier*, vol. 14, Nov. 1970, p. 786-788. In German.

Discussion of the basic aerodynamic principles involved in the flight of an aircraft taking into consideration also the effect of atmospheric conditions on the performance of the aircraft. The forces to which an aircraft in horizontal flight is subjected are examined, and relations between air flow and angle of attack are investigated. The effect of turbulence and velocity on the stresses acting on the wings is considered. It is shown how the altitude of the airport, the air temperature, and the relative humidity influence the required length of the runway. G.R.

A71-13018 A self-made man in radio electronics - Walter Dittel (Ein Selbstmademann in der Funkelektronik - Walter Dittel). *Deutscher Aerokurier*, vol. 14, Nov. 1970, p. 802-804. In German.

Discussion of the aeronautical electronic equipment designed and produced by a German firm founded and managed by Dittel. The firm was founded in 1959. Static transformers for gyroscopic devices designed by Dittel are used in jet aircraft of the Lufthansa and in all Boeing jet aircraft. Radiotelephone sets produced for gliders and power aircraft are discussed. It is pointed out that almost all components for the devices produced are made in Dittel's firm. A ground radio station designed by Dittel is described, and an instrument designed for measuring the angle of approach during landing operations is discussed. G.R.

A71-13019 Test flight with the Standard-Cirrus (Testflug mit dem Standard-Cirrus). Günter Cichon. *Deutscher Aerokurier*, vol. 14, Nov. 1970, p. 812, 813. In German.

Discussion of the design of the high-performance glider Standard-Cirrus and its behavior during a flight test. The performance of the glider during a test in which it was taken three times by an aircraft to an altitude of 1500 m is discussed. Plastic materials are used in the design of the glider. An account of cockpit design and equipment is given. G.R.

A71-13020 **Trailing-edge flap automatic system (Wölbklappen-Automatik).** Herbert Schwämmie. *Deutscher Aerokurier*, vol. 14, Nov. 1970, p. 814, 815. In German.

Discussion of an approach to improve the performance of gliders by automatic trailing-edge flap control. The theory of flying with trailing-edge flaps is considered, and the factors for obtaining the optimal gliding velocity are investigated. The technical design of a system for controlling the trailing-edge flap automatically is discussed. G.R.

A71-13036 **US Air Force. W. S. Bishop (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio).** In: *Power Sources Symposium*, 24th, Atlantic City, N.J., May 19-21, 1970, Proceedings. Symposium sponsored by the U.S. Army. Red Bank, N.J., PSC Publications Committee, 1970, p. 72-75.

Discussion of power source requirements of the USAF taking into consideration future needs anticipated for the next decade. Power requirements of typical aircraft electrical systems are discussed, and the characteristics of the power sources for satisfying these requirements are considered. Power sources for missiles and spacecraft are described. New developments needed to satisfy increased power demands expected for the future are pointed out. G.R.

A71-13077 **VITAL - A general purpose, multiple dialect automatic test language.** Michael T. Ellis (PRD Electronics, Inc., Syosset, N.Y.). In: *Automatic support systems for advanced maintainability*; Institute of Electrical and Electronics Engineers, Annual Symposium, 6th, St. Louis, Mo., October 19-21, 1970, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 7-18.

Description of the capabilities of VITAL, a general-purpose, multiple dialect, automatic test language. Its underlying software design concepts of interface-accuracy enhancing system modeling and of dialects are introduced. It is shown how the software modules, or dialects, fit together to provide a versatile, efficient language, intended to fill the gap in the standardization of automatic test equipment for the avionics industry. The interface problems inherent in automatic test equipment design and the approaches used in the described VITAL language for solving these problems are reviewed. In addition to signal dialects, VITAL contains normal arithmetic and Boolean functions together with those conditional and unconditional branching facilities which are found in any high level language. M.V.E.

A71-13080 **Flight test evaluation of an advanced on-board jet engine monitoring system.** John R. Esser (Emerson Electric Co., St. Louis, Mo.). In: *Automatic support systems for advanced maintainability*; Institute of Electrical and Electronics Engineers, Annual Symposium, 6th, St. Louis, Mo., October 19-21, 1970, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 58-69. 13 refs.

Description of an inflight automatic computer-controlled jet engine performance monitoring system designed and developed by Emerson Electric Co. and flight tested on a B707-321B aircraft. In the light of the test results, the engine performance monitoring system met its design objectives. Inflight real-time jet engine health analysis proved technically feasible. The handling and transmission of 'good engine' data could be eliminated or drastically reduced. Data acquisition and analysis turned out to be more accurate than manually acquired data. Engine faults could be detected ten to twenty-four hours sooner than with current monitoring systems. M.V.E.

A71-13083 **Dynamic inertialess simulation techniques for an advanced automatic RF and microwave test complex.** Walter Gee and Albert A. Viggiano (Lockheed Missiles and Space Co.,

Sunnyvale, Calif.). In: *Automatic support systems for advanced maintainability*; Institute of Electrical and Electronics Engineers, Annual Symposium, 6th, St. Louis, Mo., October 19-21, 1970, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 83-91. 9 refs.

Description of an advanced automatic test equipment (ATE) design concept applicable to the majority of communication, navigational aids, radar, and tactical electromagnetic systems commonly employed in missiles, satellites and high performance military and commercial aircraft. State-of-the-art design of dynamically programmable RF and microwave networks for signal characterization of emitters and simulation of the backscattered radar signal returns are discussed. The concept described is intended to upgrade RF testing techniques. It includes dynamic simulation capabilities previously confined to specialized and sophisticated laboratories. It is also to accomplish some of the tasks that currently require an actual flight test, which may be costly, subject to personnel hazards, limited in range of operation, and not easily repeated in the worst-case condition. M.V.E.

A71-13084 **The evolution and development of a digital test capability for VAST.** Edward J. Fuller (PRD Electronics, Inc., Syosset, N.Y.) and James A. Proctor (Radiation, Inc., Melbourne, Fla.). In: *Automatic support systems for advanced maintainability*; Institute of Electrical and Electronics Engineers, Annual Symposium, 6th, St. Louis, Mo., October 19-21, 1970, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 121-129. 5 refs.

This paper discusses how the overall VAST effectiveness has been enhanced through the addition of a general-purpose digital test capability. The resultant hardware and software additions required to implement this capability are discussed in relationship to a series of defined digital testing goals and ground rules. The methodology of how the various components of VAST function together to implement either a combinational or sequential test procedure is described. (Author)

A71-13085 **Automatic digital test unit.** Lester T. Byrd and James D. Graham (Emerson Electric Co., St. Louis, Mo.). In: *Automatic support systems for advanced maintainability*; Institute of Electrical and Electronics Engineers, Annual Symposium, 6th, St. Louis, Mo., October 19-21, 1970, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 130-137.

Discussion of the automatic digital test unit (ADTU) that has been developed to meet the test requirements presented by avionics systems employing digital techniques. The ADTU provides an automatic digital test and diagnostic capability for modules, sub-assembly, and line replaceable units. The equipment design, programming procedures, and application concepts developed were based on actual test requirements of contemporary and projected near-future avionics. The design emphasizes flexibility in two areas: a range of interface parameters (logic levels, etc.) to ensure compatibility with the different families of logic elements, and the ability to vary the digital capability (8 bit bites, parallel/serial separable) to optimize for a given test mission. M.V.E.

A71-13086 **Estimating ATE software costs for a support analysis study.** Phillip M. Knapp (AAI Corp., Cockeysville, Md.). In: *Automatic support systems for advanced maintainability*; Institute of Electrical and Electronics Engineers, Annual Symposium, 6th, St. Louis, Mo., October 19-21, 1970, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 158-166.

Description of a support analysis program intended to provide the means for automatically estimating software costs involved in the development of test programs for an automatic test system. This

program was designed to run on the 5500 automatic test system (ATS) presently in use for general purpose avionics support. The manual to automatic test time ratios presently experienced through use of this equipment indicate a 20 to 1 saving in test time. Through use of the support analysis program, it will be possible to quickly evaluate candidates for support on the 5500 ATS and determine those which result in significant test cost savings compared to alternate support possibilities. The program also includes means for developing a support tradeoff analysis between special support equipment, general purpose test equipment, and the automatic test system.

M.V.E.

A71-13087 VAST USER requirements. John C. Slade and M. Evans (LTV Aerospace Corp., Dallas, Tex.). In: Automatic support systems for advanced maintainability; Institute of Electrical and Electronics Engineers, Annual Symposium, 6th, St. Louis, Mo., October 19-21, 1970, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 167-172.

Description of the major USER requirements of the VAST computer controlled automatic test equipment. The tasks which must be performed by a VAST USER are defined, and the tools which are available for their performance are discussed. USER requirements include: adequate documentation, such as compatibility reports and a program design and assurance plan; utilization of special purpose auxiliary computer programs; an organized program of specialized test design personnel training; detailed and timely communications; and provision of special laboratory and software support facilities. It has been found that program cost effectiveness is greatly enhanced by an adequately defined and controlled system of design, integration, and verification procedures.

M.V.E.

A71-13088 Technical considerations for automatic testing of avionics equipment. William R. Shaffer and Joseph L. Howard (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: Automatic support systems for advanced maintainability; Institute of Electrical and Electronics Engineers, Annual Symposium, 6th, St. Louis, Mo., October 19-21, 1970, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1970, p. 173-176.

Definition of some of the long-range development goals for avionics automatic test equipment (ATE) of the future. It is felt that the third-generation ATE that the Air Force is looking for will not only use a computer to control the equipment, but will also use computers to perform the tests, calculate the parameters, evaluate the results, and predict the time of future failure. For too long a period, ATE development represented an attempt to solve present day problems without much consideration being given to the requirements of the future. Most designs have been reactive. Now, all efforts should be channeled into developing programs that will have advanced ATE available in time, and capable of solving tomorrow's testing requirements. An attempt is made to identify some of the obstacles lying across the pathway to achievement of that goal.

M.V.E.

A71-13099 Status of present knowledge of radiological risks caused by cosmic rays during flights at altitudes ranging between 16,000 and 18,000 meters (Etat actuel des connaissances sur le risque radiologique entraîné par les rayons cosmiques dans les vols à des altitudes comprises entre 16.000 et 18.000 mètres). R. P. Delahaye (Ecole d'Application de Médecine Aéronautique, Paris, France), A. Pfister (NATO, AGARD, Brussels, Belgium), G. Deltour (Centre d'Enseignement et de Recherches de Médecine Aéronautique, Division de Biophysique, Paris, France), A. Kayser (CNRS, Centre d'Etudes Nucléaires, Strasbourg-Cronenbourg, France), I. Mac Naughtan (Royal Aircraft Establishment, Farnborough, Hants.,

England), and E. W. Fuller (Atomic Weapons Research Establishment, Aldermaston, Berks., England). *Revue de Médecine Aéronautique et Spatiale*, vol. 9, 2nd Quarter, 1970, p. 85-99. 50 refs. In French.

Discussion of dangers presented by cosmic radiation to supersonic flight. The present status of physical knowledge regarding cosmic galactic radiation between 16,000 and 18,000 m is briefly reviewed, together with the status of physical and radiobiological knowledge of heavy particles of cosmic radiation, the status of physical knowledge of cosmic radiation of solar origin, and the changes caused by the structure and atmosphere of an aircraft to incident particles of cosmic radiation. It is pointed out that it is necessary to determine the extent to which the recommendations of the international commission for radiological protection and of natural organizations for the control of permissible radiation doses apply to this new situation.

M.M.

A71-13126 Progress in aeronautical sciences. Volume 10. Edited by D. Küchemann (Royal Aircraft Establishment, Farnborough, Hants., England). Oxford, Pergamon Press, Ltd., 1970, 527 p. In English and French. \$27.

Contents:

Preface. D. Küchemann (Royal Aircraft Establishment, Farnborough, Hants., England), p. vii.

Problems of thermoelasticity. W. Nowacki (Polska Akademia Nauk, Warsaw, Poland), p. 1-63. 101 refs.

The status of research in turbulent boundary layers with fluid injection. L. O. F. Jeromin (Cambridge University, Cambridge, England), p. 65-189. 138 refs.

Numerical computation of wings in the steady or unsteady supersonic state (Calcul numérique des ailes en régime supersonique stationnaire ou instationnaire). M. Fenain (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), p. 191-259. 20 refs.

Contribution to the computation of aerodynamic characteristics of an aircraft in steady or unsteady supersonic flow (Contribution au calcul des caractéristiques aérodynamiques d'un aéronef en écoulement supersonique stationnaire ou instationnaire). M. Enselme (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), p. 261-336. 16 refs.

The methods of firing tunnel study of ionization in wakes (Les méthodes d'étude au tunnel de tir de l'ionisation dans les sillages). M. Laug, M. J. Pierson, and G. Stern (Institut Franco-Allemand de Recherches, Saint-Louis, Haut-Rhin, France), p. 337-400. 117 refs.

Fluidics. J. W. Tanney (National Research Council, Ottawa, Canada), p. 401-509. 119 refs.

Author index, p. 511-517.

Subject index, p. 519-523.

A71-13129 Numerical computation of wings in the steady or unsteady supersonic state (Calcul numérique des ailes en régime supersonique stationnaire ou instationnaire). Maurice Fenain (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). In: Progress in aeronautical sciences. Volume 10. Edited by D. Küchemann. Oxford, Pergamon Press, Ltd., 1970, p. 191-259. 20 refs. In French.

Review of the general formulas available for study of wings in the steady or unsteady supersonic regime, followed by definition of a unique and characteristic network distinguishing the direct fundamental formula. The use which can be made of the approximate formula obtained is explained. For steady flow, an inverse discrete formula is established. The technique of numerical inversion of the unsteady flow is generalized.

F.R.L.

A71-13130 Contribution to the computation of aerodynamic characteristics of an aircraft in steady or unsteady supersonic flow (Contribution au calcul des caractéristiques

aérodynamiques d'un aéronef en écoulement supersonique stationnaire ou instationnaire). M. Enselme (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). In: Progress in aeronautical sciences. Volume 10. Edited by D. Küchemann. Oxford, Pergamon Press, Ltd., 1970, p. 261-336. 16 refs. In French.

Attempt to develop an analog method of computation which makes it possible to solve, within the framework of lifting surfaces, various problems of supersonic flow. The principle of computation for the wing alone is first discussed, followed by description of the electrical device making possible the application of boundary conditions. Examples are given to illustrate the possibilities of this computation, which is compared with theoretical results. The analog solution is then extended to the interactions, especially those between the wing and a cylindrical fuselage. The principle of computation for a wing in an unsteady flow is given, and its application is developed. F.R.L.

A71-13131 The methods of firing tunnel study of ionization in wakes (Les méthodes d'étude au tunnel de tir de l'ionisation dans les sillages). M. Laug, M. J. Pierson, and G. Stern (Institut Franco-Allemand de Recherches, Saint-Louis, Haut-Rhin, France). In: Progress in aeronautical sciences. Volume 10. Edited by D. Küchemann. Oxford, Pergamon Press, Ltd., 1970, p. 337-400. 117 refs. In French.

Study of three characteristic points along a supersonic wake, which are always located in a definite order starting from the projectile. These are (1) the throat, situated between the pressure drop and the wake itself, (2) the transition point between the laminar flow and the turbulent flow, and (3) the breakthrough point. The hyperballistic firing tunnel is shown to be an extremely powerful means of studying ionized wakes left by a hypersonic body at the time of its reentry into the atmosphere. F.R.L.

A71-13133 Progress in aerospace sciences. Volume 11. Edited by D. Küchemann (Royal Aircraft Establishment, Farnborough, Hants., England). Oxford, Pergamon Press, Ltd., 1970. 358 p. In English and French. \$27.

Contents:

Preface. D. Küchemann (Royal Aircraft Establishment, Farnborough, Hants., England), p. vii.

Dynamic aeroelastic calculations of aircraft based on ground-vibration test data. H. Försching (Aerodynamische Versuchsanstalt, Göttingen, West Germany), p. 1-66. 27 refs.

Effects of turbulence on aeronautical systems. J. A. Dutton (Pennsylvania State University, University Park, Pa.; USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio), p. 67-109. 39 refs.

Problems of aircraft flight in turbulence (Problèmes du vol d'un avion en turbulence). G. Coupry (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), p. 111-181. 53 refs.

Atmospheric turbulence at the cruise altitudes of supersonic transport aircraft. J. Burnham (Royal Aircraft Establishment, Bedford, England), p. 183-234. 23 refs.

Interactions between shock waves and turbulent boundary layers. J. E. Green (Royal Aircraft Establishment, Bedford, England), p. 235-340. 76 refs.

Author index, p. 341-343.

Subject index, p. 345-348.

A71-13134 Dynamic aeroelastic calculations of aircraft based on ground-vibration test data. H. Försching (Aerodynamische Versuchsanstalt, Göttingen, West Germany). In: Progress in aerospace sciences. Volume 11. Edited by D. Küchemann. Oxford, Pergamon Press, Ltd., 1970, p. 1-66. 27 refs.

The principles and related problems of dynamic aeroelastic calculations of aircraft using experimental ground-vibration test data

are described. In the theoretical analysis the governing aeroelastic equations are given in terms of normal coordinates including rigid-body freedoms and the effects of running engines. Special emphasis is given to the problem of an adequate formulation and consideration of structural damping of the real aircraft in aeroelastic investigations. Finally, some examples of practical flutter calculations based on ground-vibration test data are demonstrated. (Author)

A71-13135 * Effects of turbulence on aeronautical systems. John A. Dutton (Pennsylvania State University, University Park, Pa.; USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: Progress in aerospace sciences. Volume 11. Edited by D. Küchemann. Oxford, Pergamon Press, Ltd., 1970, p. 67-109. 39 refs. NSF Grant No. GA 1595X; Contract No. NAS 8-21140.

Aeronautical systems, in relation to atmospheric turbulence, are essentially deterministic devices forced by a random environment. The deterministic description must be coupled with a statistical description of the structure of the turbulent forcing to obtain a statistical prediction of the effects of turbulence. Broad aspects of the present knowledge of turbulence and the mathematical difficulties associated with converting this knowledge into practical aeronautical design procedures are considered. The extent to which aeronautical applications are permeated by the assumption that the turbulent motion is a Gaussian process is emphasized; complications introduced by abandoning the assumption are discussed. The present challenges include resolution of the relation between probabilistic structure of turbulence and response exceedance statistics, determination of the structure of the largest gusts, and the combined problem of developing mathematical methods for representing turbulent velocities for both simulation and the study of nonlinear effects. Some aspects of these challenges are discussed. (Author)

A71-13136 Problems of aircraft flight in turbulence (Problèmes du vol d'un avion en turbulence). G. Coupry (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). In: Progress in aerospace sciences. Volume 11. Edited by D. Küchemann. Oxford, Pergamon Press, Ltd., 1970, p. 111-181. 53 refs. In French.

Estimation of the effect of clear air turbulence on flight conditions, and analysis of the structural response of an aircraft to this turbulence. The local turbulence model and the Press (1952) global model are detailed. The analytical techniques used for determining clear air turbulence are described, together with methods based on velocity, gravity, and height recordings. The response of aircraft to the local Gaussian stationary and global gust loads is examined. A statistical calculation of the aircraft response is presented. The techniques used for improving flight conditions in turbulent air are reviewed. Z.W.

A71-13137 Atmospheric turbulence at the cruise altitudes of supersonic transport aircraft. J. Burnham (Royal Aircraft Establishment, Bedford, England). In: Progress in aerospace sciences. Volume 11. Edited by D. Küchemann. Oxford, Pergamon Press, Ltd., 1970, p. 183-234. 23 refs.

On the basis of current knowledge, of which an outline is given, it appears that many of the fears which have been advanced in recent years about the frequency and intensity of the turbulence which will be encountered during cruise by supersonic transports have almost certainly been exaggerated. Partly as the result of the characteristics of the aircraft, which make it less rather than more sensitive to gusts than are the current subsonic jets, and partly because, on average, turbulence of a given intensity is less frequent at the higher altitudes, the probability of encountering gust induced accelerations of a given size on a supersonic transport is likely to be considerably less than it is on the current subsonic jets. Severe gusts do occur at the higher altitudes, although less frequently, in association both with thunderstorms and with mountain waves. In the case of the latter, no change

in operating practices is likely to be needed to maintain the current level of success in avoidance. So far as thunderstorm avoidance is concerned, care will be needed in the operation and interpretation of the weather radar if current levels of success are to be maintained, since problems may arise which do not occur at the lower altitudes at which subsonic aircraft fly. (Author)

A71-13139 Flow research on blading; Proceedings of the First Brown Boveri Symposium, Baden, Switzerland, March 10, 11, 1969, Proceedings. Edited by L. S. Dzung (Brown Boveri and Co., Ltd., Baden, Switzerland). Amsterdam, Elsevier Publishing Co., 1970. 414 p. In English, German, and French. \$26.

Contents:

Foreword. P. Hummel and A. P. Speiser (Brown Boveri and Co., Ltd., Baden, Switzerland), p. v-viii.

Preface. L. S. Dzung (Brown Boveri and Co., Ltd., Baden, Switzerland), p. ix, x.

Aerodynamic aspects of blading research. L. S. Dzung and C. Seippel (Brown Boveri and Co., Ltd., Baden, Switzerland), p. 1-50.

Quasi-three-dimensional flow in a multistage turbine - Calculation and experimental verification. A. Renaudin and E. Somme (Société Electro-Mécanique, Le Bourget, France), p. 51-87.

Results of turbine tests at the Institute for Turbomachines at the ETH, Zürich (Ergebnisse von Turbinenversuchen am Institut für Thermische Turbomaschinen an der ETH, Zürich). W. Traupel (Zürich, Technische Hochschule, Zürich, Switzerland), p. 88-150.

Flow in cascades with a transonic regime. J. Chauvin, C. Sieverding, and H. Griepentrog (Von Kármán Institute for Fluid Dynamics, Rhode St. Genèse, Belgium), p. 151-196. 37 refs.

Aerodynamic damping of two-mode blade vibrations. R. Legendre (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), p. 197-209.

Theoretical analysis of turbulent separation and reattachment at the trailing edge of a blade at supersonic speeds (Analyse théorique du décollement et du recollement turbulents au bord de fuite d'un aube aux vitesses supersoniques). P. Carrière (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), p. 210-242. 12 refs.

On the influence of turbulence level on the aerodynamic losses of axial turbomachines. H. Schlichting and A. Das (Braunschweig, Technische Universität; Deutsche Forschungsanstalt für Luft- und Raumfahrt, Braunschweig, West Germany), p. 243-274. 36 refs.

Casing boundary layers in multistage axial-flow compressors. L. H. Smith, Jr. (General Electric Co., Cincinnati, Ohio), p. 275-304. 12 refs.

Radial forces on impeller of volute casing pumps. U. Domm and P. Hergt (Klein, Schanzlin and Becker AG, Frankenthal, West Germany), p. 305-321. 11 refs.

Boundary layer problems in axial turbomachines. J. H. Horlock (Cambridge University, Cambridge, England), p. 322-371. 77 refs.

Turbulent boundary layer prediction and structure - The state of the art. S. J. Kline (Stanford University, Stanford, Calif.), p. 372-396. 36 refs.

Author index, p. 397.

Subject index, p. 398.

A71-13140 Flow in cascades with a transonic regime. J. Chauvin, C. Sieverding, and H. Griepentrog (Von Kármán Institute for Fluid Dynamics, Rhode St. Genèse, Belgium). In: Flow research on blading; Proceedings of the First Brown Boveri Symposium, Baden, Switzerland, March 10, 11, 1969, Proceedings.

Edited by L. S. Dzung. Amsterdam, Elsevier Publishing Co., 1970, p. 151-189; Discussion, p. 189-196. 37 refs. Grants No. AF EOAR 63-84; No. AF EOAR 64-4; No. AF EOAR 65-65; Contract No. AF 61(052)-67-C-0018.

The different types of flow in blading for the transonic regime,

i.e., for which the sonic velocity is reached one or several times inside the blade passage, are presented. Turbomachine flow with supersonic inlet and subsonic outlet Mach numbers, subsonic inlet and supersonic outlet Mach numbers, subsonic inlet and outlet Mach numbers with local supersonic regions is considered. A physical description of the flow is given and the factors influencing the blade performance at nominal point (i.e., inlet air angle and losses in function of outlet conditions) are described. The phenomena involved do not allow for a full theoretical treatment; some simple theoretical models are discussed, which could be used as support for experimental correlations. For the case of flow with subsonic inlet and outlet Mach number, a semi-empirical method of calculation is presented which gave satisfactory results for high-solidity compressor blading. It is concluded that significant progress in the understanding of the flow and in the prediction of performance will be obtained only from a better knowledge of the shock boundary layer interaction phenomena. (Author)

A71-13141 Aerodynamic damping of two-mode blade vibrations. Robert Legendre (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). In: Flow research on blading; Proceedings of the First Brown Boveri Symposium, Baden, Switzerland, March 10, 11, 1969, Proceedings. Edited by L. S. Dzung. Amsterdam, Elsevier Publishing Co., 1970, p. 197-207; Discussion, P. Suter (Sulzer AG, Winterthur, Switzerland), D. S. Whitehead (Cambridge University, Cambridge, England), and W. Endres (Brown Boveri and Co., Ltd., Baden, Switzerland), p. 207-209. Research sponsored by Electricité de France.

The problem of blade vibrations in turbomachinery is discussed and the importance of aerodynamic damping is underlined. The results obtained from previous research are summarized and the reasons for the study of two simultaneous modes of vibration are explained. The new results confirm the great importance of aerodynamic damping and of the shifts of the natural frequencies. (Author)

A71-13142 Theoretical analysis of turbulent separation and reattachment at the trailing edge of a blade at supersonic speeds (Analyse théorique du décollement et du recollement turbulents au bord de fuite d'un aube aux vitesses supersoniques). Pierre Carrière (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). In: Flow research on blading; Proceedings of the First Brown Boveri Symposium, Baden, Switzerland, March 10, 11, 1969, Proceedings.

Edited by L. S. Dzung. Amsterdam, Elsevier Publishing Co., 1970, p. 210-240; Discussion, p. 240-242. 12 refs. In French.

A turbulent separation may intervene in the neighbourhood of the trailing-edge of a blade in some working conditions and this may limit the machine performance. At this stage a theoretical study of this phenomenon is possible but using a two-dimensional model only. The model suggested comprises a zone of so-called free-separation followed by an isobaric separated zone preceding the zone of re-attachment to the lower surface flow. Present knowledge on each of these fundamental problems is reviewed. The recent improvements to the well-known models of D. Chapman on free separation, and of H. Korst on re-attachment, are underlined and it is shown that it is now possible for engineers to predict these phenomena with a good precision in many cases. (Author)

A71-13143 On the influence of turbulence level on the aerodynamic losses of axial turbomachines. H. Schlichting and A. Das (Braunschweig, Technische Universität; Deutsche Forschungsanstalt für Luft- und Raumfahrt, Braunschweig, West Germany). In: Flow research on blading; Proceedings of the First Brown Boveri Symposium, Baden, Switzerland, March 10, 11, 1969, Proceedings. Edited by L. S. Dzung. Amsterdam, Elsevier Publishing Co., 1970, p. 243-268; Discussion, p. 268-274. 36 refs.

Analysis of the losses in cascades at small Reynolds numbers, and description of the behavior of the pertaining boundary layer under the effect of a varying degree of turbulence. The origin and

nature of losses in axial turbomachines are examined. The influence of the Reynolds number on the losses in blading is analyzed. The effect of artificially generated turbulence on the aerodynamic losses is discussed. Some results of investigations concerning the boundary layer of blades at various turbulence levels of inflow are presented.

Z.W.

A71-13144 **Casing boundary layers in multistage axial-flow compressors.** Leroy H. Smith, Jr. (General Electric Co., Aircraft Engine Technical Div., Cincinnati, Ohio). In: *Flow research on blading; Proceedings of the First Brown Boveri Symposium, Baden, Switzerland, March 10, 11, 1969, Proceedings.*

Edited by L. S. Dzung. Amsterdam, Elsevier Publishing Co., 1970, p. 275-304; Discussion, p. 300-304. 12 refs.

The repeating-stage flow model in which the velocity distributions leaving a stage are taken to be the same as those entering it is discussed and adopted. Experimental data are presented to support the hypothesis that, in many cases of interest, the axial velocity distribution can be meaningfully divided into three regions: a free-stream region and two end-wall-boundary-layer regions. It is further proposed that the end-wall (casing) boundary layer thicknesses depend primarily on three things: the blade-to-blade passage width, the aerodynamic loading level, and clearances. With knowledge of these it is possible to predict how the pressure-flow and efficiency-flow characteristic curves are affected when blade aspect ratio is changed with dimensionless cascade geometry held fixed. Supporting data from a four-stage low-speed compressor in which aspect ratio was varied from 2 to 5 are presented. (Author)

A71-13146 **Boundary layer problems in axial turbomachines.** J. H. Horlock (Cambridge University, Cambridge, England). In: *Flow research on blading; Proceedings of the First Brown Boveri Symposium, Baden, Switzerland, March 10, 11, 1969, Proceedings.*

Edited by L. S. Dzung. Amsterdam, Elsevier Publishing Co., 1970, p. 322-360; Discussion, p. 360-371. 77 refs.

Review of the current state of knowledge concerning boundary layer flows in axial turbomachines. The complex nature of the boundary layers developing in an axial-flow turbomachine is discussed. Attempts to calculate the two-dimensional profile boundary layers (both laminar and turbulent) in cascades are described, and the results are compared with experiment. In extending such calculations to the flow in a turbomachine, account was taken of: (1) higher turbulence levels, (2) blockage due to the development of the wall boundary layers and the consequent contraction of the mainstream flow, and (3) the effects of centrifugal and Coriolis forces associated with swirl and rotation respectively. Solution of the annulus wall boundary layer problem is approached by the axisymmetric method, and the results are compared with experiment. Z.W.

A71-13147 **Turbulent boundary layer prediction and structure - The state of the art.** S. J. Kline (Stanford University, Stanford, Calif.). In: *Flow research on blading; Proceedings of the First Brown Boveri Symposium, Baden, Switzerland, March 10, 11, 1969, Proceedings.*

Edited by L. S. Dzung. Amsterdam, Elsevier Publishing Co., 1970, p. 372-392; Discussion, E. Litvai (Budapesti Műszaki Egyetem, Budapest, Hungary), W. S. Hall (C. A. Parsons and Co., Ltd., Newcastle-upon-Tyne, England), N. Scholz (MAN-Turbo GmbH, Munich, West Germany), and J. H. Horlock (Cambridge University, Cambridge, England), p. 392-396. 36 refs.

Review of the current status of knowledge concerning the structure of turbulence and the ability to predict turbulent boundary layers. It is concluded that adequate prediction methods are available for attached, two-dimensional incompressible, turbulent boundary layers on smooth surfaces. Evidence is accumulating which suggests that the process of turbulence production occurs via a local

instability of the mean or instantaneous profiles that pump energy from the mean flow to the fluctuations. One calculation, based on the idea that the amount of turbulence production in a statistically stable flow field is that amount necessary to make the field marginally dynamically stable, has succeeded for the first time in determining the mean velocity field and the turbulent shear in a highly degenerate turbulent shear flow. Z.W.

A71-13148 # **Problems on inlets and nozzles.** D. Zonars (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *International Council of the Aeronautical Sciences, Congress, 7th, Rome, Italy, Sept. 14-18, 1970, Paper ICAS 70-47.* 12 p. 27 refs.

The wide range of Mach number and altitude requirements placed on high performance aircraft has resulted in a number of inlet and nozzle problems reflecting adversely upon flight performance and maneuverability. These circumstances have emphasized the need for greater understanding of the airframe induced flow fields and how these fields interact with inlet and nozzle systems. Inlet-airframe interactions involving local flow angularities and Mach number effects measured about a wing-body wind tunnel model at transonic and supersonic speeds are presented. Also, the influence of internal inlet flow turbulence is assessed since this phenomenon can contribute significantly to engine instability during supersonic flight. The nozzle portion of the paper examines the drag losses associated mainly with twin-jet configurations. Attendant variations in lateral nozzle spacing, aft-end fineness ratio and nozzle pressure ratio are evaluated as a function of transonic Mach numbers. (Author)

A71-13195 # **Controllability of heavy supersonic aircraft (Upravliaemost' tiazhelykh sverkhzvukovykh samoletov).** E. Elian, F. Sklianskii, and A. Kuznetsov. *Aviatsia i Kosmonavtika*, Oct. 1970, p. 18-20. In Russian.

Discussion of the controllability of heavy supersonic aircraft during various phases of flight. Special attention is given to the irreversible boost control system used on this class of aircraft and requiring special handling. The effects of this control system on various types of aircraft stability are analyzed. A less effective damping of the intrinsic vibrations at supersonic speed at high altitudes and a reverse roll response to a foot control action are noted as special control problems experienced on heavy supersonic aircraft. V.Z.

A71-13257 **Welding of superalloy turbine hardware.** R. W. King, R. W. Hatala, and H. A. Hauser (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Metals Engineering Quarterly*, vol. 10, Nov. 1970, p. 55-58.

Description of the weld repair of thermal fatigue cracks in turbine vanes. It is shown that the plasma arc fusion welding technique is superior to the conventional TIG process for the manual repair of cast B-1900 nickel-base alloy turbine vanes. Using the plasma arc method, sound trailing edge repair welds to a depth approximately 1/2 in. were made without external preheating. Z.W.

A71-13277 **Generation of sound by rotor-stator interaction.** S. Kaji and T. Okazaki (Tokyo, University, Tokyo, Japan). *Journal of Sound and Vibration*, vol. 13, Nov. 1970, p. 281-307. 14 refs.

Theoretical study of the sound generation by rotor-stator interaction, which is the main cause of discrete frequency noise from subsonic compressors, taking into account the effect of compressibility of fluid. The combination of a single stator row and a single rotor row in a two-dimensional subsonic flow field is chosen as the interaction model, and two types of interaction, i.e., potential interaction and wake interaction, are treated separately. By determining the unsteady lift distributions of the rotor and stator simultaneously in proper phase and amplitude, the sound pressures upstream and downstream are calculated in a form which includes the contributions from sound sources of both rows. In addition to

the symmetric mode involves strongly interacting long waves. An argument is presented that $d/b = 0.07$ for the vortices trailing from an elliptically loaded wing. (Author)

A71-13437 # Boundary-layer displacement and leading edge bluntness effects on attached and separated laminar boundary layers in a compression corner. I - Theoretical study. Michael S. Holden (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). (*American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 6th, New York, N.Y., Jan. 22-24, 1968, Paper 68-68.*) *AIAA Journal*, vol. 8, Dec. 1970, p. 2179-2188. 19 refs. Contract No. AF 33(615)-67-C-1298.

A study has been conducted to examine the influence of boundary layer displacement and leading edge bluntness on the properties of attached and separated laminar boundary layers in the high-temperature hypersonic flow over a compression corner. The theoretical analysis uses the boundary layer equations in their integral form to describe both attached and separated interaction regions developed over a sharp flat plate-wedge compression surface. The theory has been compared with pressure, heat transfer, and skin friction measurements for cases where the boundary layers upstream of the corner interaction lie in the "weak" and "strong" interaction regimes. In the complementary experimental study conducted in the 4-ft and 6-ft shock tunnels, heat transfer, pressure, skin friction, and schlieren measurements were made in attached and separated flows over flat plate-wedge compression surfaces in a hypersonic airflow. The effect on the compression corner flow of the favorable pressure gradient induced on a sharp flat plate upstream of the corner was studied for a range of free-stream Mach numbers from 14 to 20 and unit Reynolds numbers from 2000 per inch to 14,000 per inch. Thus, the measurements spanned the "weak" and "strong" interaction regimes ($1 < \bar{X}_L < 30$) over the flat plate. The effect of combined leading edge bluntness and boundary layer displacement on attached and separated regions over flat plate-wedge compression surfaces was examined experimentally. (Author)

A71-13467 # Reducing ballistic range data for the projectile's drag coefficient. C. T. Crowe (Washington State University, Pullman, Wash.) and R. Carlson (United Aircraft Corp., United Technology Center Div., Sunnyvale, Calif.). *AIAA Journal*, vol. 8, Dec. 1970, p. 2297-2299. 10 refs. Grant No. DA-HC-04-67-C-0057.

Description of a ballistic data-reduction technique for determining the drag coefficient of spherical projectiles in flow regimes where the drag coefficient does not vary appreciably with velocity, such as hypersonic flow. The time distance relation for a projectile with a constant drag coefficient is used, and that value which provides the best fit with the data is determined. M.M.

A71-13565 # Social and industrial implications of V/STOL transportation systems. I. C. Cheeseman, M. Judd, and G. M. Lilley (Southampton, University, Southampton, England). *British Air Line Pilots Association, Technical Symposium on V/STOL in Civil Aviation, London, England, Nov. 24-26, 1970, Paper. 51 p.* 14 refs.

Discussion of the potential of V/STOL aircraft in meeting the demands of multirole short-haul air transport requirements within the next 20 yr. These requirements include intercity travel, the connecting up with international air routes, and integration with interurban surface transport systems. Attention is given to the factors favoring the V/STOL system such as its flexibility, especially in relation to long-term population shifts, and to its advantages over certain surface transport systems for intercity stage lengths as short as 100 km, provided a multistop capability is introduced. Emphasis is placed on the relative importance of direct operating and indirect operating costs of these short-haul air transport systems, the requirement of all-weather operation, the requirements for maintenance and overhaul, and on the necessity for good road communications. F.R.L.

A71-13566 # Inter urban and inter city V/STOL services. A. S. Crossfield (Eastern Air Lines, Inc., New York, N.Y.). *British Air Line Pilots Association, Technical Symposium on V/STOL in Civil Aviation, London, England, Nov. 24-26, 1970, Paper. 27 p.*

Argument in favor of a speedy development and implementation of a STOL short-haul air transportation system designed to serve the short-haul market demands which currently reach the point of severely restricting the peak-hour traffic movements at major U.S. terminals. Experiences of Eastern Air Lines, in particular the high cost of nonproductive flying caused by traffic congestion, are cited in support of the need for STOL introduction. V.Z.

A71-13567 # Integration of V/STOL in the Air Traffic System. W. E. J. Groves (Decca Navigator Co., Ltd., London, England). *British Air Line Pilots Association, Technical Symposium on V/STOL in Civil Aviation, London, England, Nov. 24-26, 1970, Paper. 24 p.* 6 refs.

Review of the problems involved in the process of integration of V/STOL services in the air traffic system of the United Kingdom. The topics include the present UK domestic traffic, operating environment, STOL operation integration at existing airports and at urban STOL airports, VTOL operations at city centers, and navigation guidance and integration. It is assumed that STOL services will commence with 20-40 seater aircraft having cruising speeds from 150 to 200 Kts. and operating below F.L.100, and that aircraft with a minimum 100 seats and an optimum cruise speed from 300 to 400 Kts. may be used by the end of the 1970's. V.Z.

A71-13568 # Safety level and STOL performance. L. J. W. Hall and P. Meiklem (Air Registration Board, Redhill, Surrey, England). *British Air Line Pilots Association, Technical Symposium on V/STOL in Civil Aviation, London, England, Nov. 24-26, 1970, Paper. 16 p.*

Discussion of a method of deriving an airworthiness target for aircraft in the early 1980s and of various aspects regarding STOL performance and handling. The method considered is based on the current fatal accident record of jet aircraft, taking into account learning accidents, and assuming a perpetuation of the current proportion of fatal accidents due to airworthiness causes. In operations from urban areas, third party considerations are judged to be of possible significance, particularly during the introductory years. It is shown that it will be necessary to restate existing requirements in a more basic form in order to adapt them to the needs of STOL aircraft. The need to link airworthiness and operational considerations even more closely than before in trying to ensure an adequate safety level is explained. G.R.

A71-13571 # Design considerations of intercity V/STOL aircraft. M. J. Brennan (Hawker Siddeley Aviation, Ltd., Kingston-upon-Thames, Surrey, England). *British Air Line Pilots Association, Technical Symposium on V/STOL in Civil Aviation, London, England, Nov. 24-26, 1970, Paper. 53 p.*

Consideration of the proposition that V/STOL aircraft offer a method of developing a transport system which can solve the increasing problem of intercity traffic congestion. V/STOL aircraft are economical of resources, and are compatible with the community from the point of view of noise. Other intercity transportation systems inevitably face the ultimate problem of saturation, as is illustrated by the congested air terminals and motorways throughout the world. It is suggested that, because the VTOL aircraft will take off and land under separate air traffic control it will not be subject to congestion and, because of all-weather superiority, the loss from weather close-down and diversions will be less for VTOL than for STOL and conventional aircraft. Various powerplant configurations are evaluated. F.R.L.

A71-13572 # V/STOL operations - Present and future. R. Williams (British Airline Pilots Association, Harlington Hayes, Middx., England). *British Air Line Pilots Association, Technical Symposium on V/STOL in Civil Aviation, London, England, Nov. 24-26, 1970, Paper.* 11 p.

Consideration of various present and future aspects of V/STOL operations, such as terminals, landing and approach aids, air traffic, noise and pollution control, safety, performance, and airworthiness regulations and licensing. It is emphasized that, with steady progress and development, it will be possible to select correct systems and make the decisions to ensure that the chosen system is introduced into a compatible operating environment. F.R.L.

A71-13573 * # Operations of V/STOL aircraft in the terminal area. Robert O. Schade, John F. Garren, Jr., Henry L. Kelley, and Robert E. Shanks (NASA, Langley Research Center, Hampton, Va.). *British Air Line Pilots Association, Technical Symposium on V/STOL in Civil Aviation, London, England, Nov. 24-26, 1970, Paper.* 55 p. 16 refs.

Discussion of highlights of research work being done with some of the more promising V/STOL concepts for operation in the terminal area which appear to have future commercial applications. Attention is given to future V/STOL approaches, the desirability of using variable speed on the final approach, the effects of wind and speed during low-speed operation, and other related problem areas, such as noise. F.R.L.

A71-13574 Landing guidance for VTOL aircraft. I. M. Hunter and J. E. Nethaway (Royal Aircraft Establishment, Farnborough, Hants., England). *British Air Line Pilots Association, Technical Symposium on V/STOL in Civil Aviation, London, England, Nov. 24-26, 1970, Paper.* 27 p.

Description of a system which offers a very precise short-range three-dimensional surveillance system and ground computer to evaluate the optimum VTOL aircraft maneuver with a minimum of airborne complexity. It is shown that the use of the computer offers very great flexibility including multiple flight paths, multiple aircraft types, and freedom of choice of equipment site, as well as redundancy and integrity. The control system of the aircraft is likely to be electrically signalled, possibly with a mechanical backup, and will probably incorporate a failure-survival autostabilizer. The pilot's display system will be extremely important because the pilot may be unable to see the landing pad for the greater part of the transition and hover. F.R.L.

A71-13575 # The introduction of VTOL systems into commercial short-haul air transportation. R. H. Shatz (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *British Air Line Pilots Association, Technical Symposium on V/STOL in Civil Aviation, London, England, Nov. 24-26, 1970, Paper.* 26 p. 6 refs.

Air transportation is in the midst of a crisis. Systems congestion, caused by continued dynamic growth, is the basic reason for current airline losses and passenger delays and inconvenience. Major airports must be prepared for long-haul air transportation, and short-haul system improvement could be attained through the development of a VTOL system operating from city-center V-ports. It is proposed to use large helicopters for initial VTOL system operation and to develop compound aircraft for increased system capacity. This system could be installed rapidly at low risk and cost to operate profitably and efficiently without environmental degradation. European and U.S. airlines using this VTOL system could begin operations in about two years. (Author)

A71-13576 # V/STOL in civil aviation - Propulsion for V/STOL. R. M. Denning (Rolls-Royce, Ltd., Bristol, England). *British Air Line Pilots Association, Technical Symposium on V/STOL in Civil Aviation, London, England, Nov. 24-26, 1970, Paper.* 12 p.

The continuing progress of Air Transport now requires the introduction of V/STOL systems and the UK has an advantageous basis from which to develop this technology. The ultimate choice between VTOL and STOL is not yet evident but both systems promise considerable social benefit. The various Engineering systems are under active consideration in a number of countries with timescale influencing choice. The requirements of low noise and short field length dominate the engineering problems. Their achievement will bring major reductions in noise, pollution, and economy in land usage, particularly if coupled with the diversion of most short-haul traffic to V/STOL systems. Three distinct engine types involving the high bypass turbo-fan, in some form, which might power alternative aircraft solutions can be identified. These are the specialized quiet propulsion engine, the multifunction blowing/propulsion engine and the lift-fan. A return to the gearbox employed between fan and gas generator may be required for noise and performance reasons, and problems of thrust modulation on approach and reversal on landing may require innovation for their solution. Many new safety, reliability and maintainability considerations will be introduced, but practical airframe/engine concepts appear to be emerging. (Author)

A71-13579 # Fluid dynamics of jets. Yasuo Komatsu. *Nihon University, Research Institute of Science and Technology, Journal*, Sept. 1970, p. 1-75. 36 refs. In Japanese, with abstract in English.

Evaluation of different processes of development of jet flow with different boundary conditions. Initial experiments were made on conventional axisymmetric jet flow of uniform velocity at the outlet in order to obtain basic data for further investigations. In order to examine flow conditions under nonuniform velocity distribution at the outlet, an experiment was made on jet flow conditions which may occur when a medium is discharged at the end of a long circular pipe with a fully developed turbulent velocity distribution. Jet flow of uniform velocity at nozzles with an elliptic outlet was also investigated. As a practical problem, a theoretical analysis of and experiments on the behavior of an axisymmetric jet on vertical impingement on a solid surface were carried out. M.M.

A71-13618 # STOL - Creating a good neighbor. Robin K. Ransone (American Airlines, Inc., New York, N.Y.). *Astronautics and Aeronautics*, vol. 8, Dec. 1970, p. 30-37.

Discussion of STOL aircraft as a means for creating a short-haul air transport system acceptable economically, ecologically, sociologically, and emotionally to both passengers and neighbors. Neighborhood stolport ownership is considered as a new approach to this problem, promising to produce a socially viable system. Cost, noise, pollution, safety, and organizational aspects of this system are considered. The Floating Interim Manhattan Stolport (FIMS) technical feasibility study undertaken by American Airlines under contract with the FAA is outlined. V.Z.

A71-13619 # A VTOL solution now to short-haul problems. Robert H. Shatz (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *Astronautics and Aeronautics*, vol. 8, Dec. 1970, p. 38-45. 8 refs.

Discussion of the use of VTOL aircraft and compound aircraft as an effective step in the improvement of the quality of short-haul air transportation currently handicapped by airport congestion and access delays. Prototype compact downtown V-port designs for these

craft are suggested as a means of relieving the passenger from the current traffic snarl which opens the way to further air transportation expansion. V.Z.

A71-13620 # Short-haul STOL concepts in perspective. A. Scott Crossfield (Eastern Air Lines, Inc., New York, N.Y.). *Astronautics and Aeronautics*, vol. 8, Dec. 1970, p. 46-55.

Analysis of prospects for a nationwide application of short-haul STOL concepts, in view of the urgent need in improved convenience of current air transportation as shown by experiences of Eastern Air Lines. The topics include the cost of current nonproductive flying due to traffic congestion; the profit-and-loss potentials of stolports, onboard avionics, air traffic control systems, and vehicle characteristics; specific requirements of downtown access in individual cities; and a typical area-navigation system. The various tradeoffs involved in STOL operations are discussed. V.Z.

A71-13660 * # The laminar boundary layer on spinning bodies of revolution. Ralph John Muraca (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Sounding Rocket Technology Conference, 2nd, Williamsburg, Va., Dec. 7-9, 1970, Paper 70-1377*. 40 p. 39 refs. Members, \$1.50; nonmembers, \$2.00.

The subject of this paper is the analysis and solution of the equations describing the laminar boundary layer on axisymmetric bodies immersed in an oncoming stream and spinning at a constant rate about their axis of revolution. The flow is allowed to be compressible or incompressible and the geometries for which solutions are obtained include the sphere, cone, paraboloid, hyperboloid, and tangent ogive. The only limitation on spin rate involves the assumption that the pressure across the boundary layer remains essentially constant. The method of solution for the set of parabolic nonlinear partial differential equations which describe the boundary layer is an implicit finite difference technique. Comparisons with previous approximate methods are also presented in an effort to establish confidence in these results. Boundary-layer characteristics in the form of shear stress, heat transfer, velocity and temperature profiles, displacement thickness and frictional drag and moment coefficients are presented for each geometry over a wide range of spin rates. (Author)

A71-13687 Digital computers. W. H. McKinlay (Ferranti, Ltd., Edinburgh, Scotland). *Flight International*, vol. 98, Nov. 26, 1970, p. 844a-846.

Discussion of digital computers and their applications giving particular attention to the employment of the computers in aviation electronics. It is pointed out that the digital computer can form part of an automatic control loop in an autopilot or be associated with an engine. It can be programmed to adapt more easily to changes in the flight regime than an analog system. The employment of very small digital computers for producing devices which themselves depend on computing for their operation is discussed. G.R.

A71-13703 # Flow separation and reattachment in confined jet mixing. John T. Exley (Avco Corp., Avco Lycoming Div., Stratford, Conn.) and John A. Brighton (Pennsylvania State University, University Park, Pa.). *American Society of Mechanical Engineers, Paper no. 70-FE-8*, 1970. 7 p. 10 refs. Members, \$1.00; nonmembers, \$2.00. Contract No. DA-31-124-ARO(D)-452.

An experimental and theoretical investigation was conducted to study flow separation and reattachment for a confined axisymmetric jet. The fluid was air with an initially uniform velocity jet mixing with an initially uniform (but lower velocity) secondary flow. Both streams were at the same temperature and mixed in a constant-

diameter duct. The location of the points of separation and reattachment and the line of zero velocity were determined by injecting smoke into the flow. Measurements were made over a wide range of diameter ratios (nozzle diameter to mixing tube diameter) and velocity ratios (jet velocity to secondary velocity at the inlet). The separation point was strongly affected by the velocity ratio - moving upstream with an increase in velocity ratio. Reattachment, however, was only slightly affected by velocity ratio. A single parameter, such as the Curtet number, was found to be inadequate in describing separation and reattachment over all diameter ratio and velocity ratio conditions. (Author)

A71-13707 # Effect of a high traction fluid on skidding in a high speed roller bearing. W. M. Kacmarsky and L. O. Hewko (General Motors Corp., New Departure-Hyatt Bearings Div., Sandusky, Ohio). *American Society of Mechanical Engineers, Paper no. 70-Lub-E*, 1970. 6 p. 9 refs. Members, \$1.00; nonmembers, \$2.00.

Laboratory tests run under skid-prone conditions have shown that cage skid in a lightly loaded roller bearing, operating at speeds up to 3 million DN, can be reduced by using a high traction fluid as the bearing lubricant. With a Mil-L-23699 oil, maximum cage slip approached 65 percent. When the military specification oil was replaced by a fluid blended to develop a high coefficient of traction, the maximum cage slip, in the same bearing, was reduced to approximately 3 percent. The high traction oil did not comply with the Mil Specification; however, the dramatic reduction in skidding demonstrated the desirability of increasing the traction coefficients for fluids used to lubricate aircraft jet engine mainshaft bearings. (Author)

A71-13712 # Dynamic stability of Hovercraft in heave. H. J. Davies (Southampton, University, Southampton, England) and G. A. Poland (Portsmouth Polytechnic, Portsmouth, England). *American Society of Mechanical Engineers, Paper no. 70-APM-QQQ*, 1970. 6 p. 5 refs. Members, \$1.00; nonmembers, \$2.00.

The regimes of flow governing the dynamic behavior of a two-dimensional mathematical model of an edge-jet Hovercraft in heaving motion are described and the equations associated with such regimes derived. Both the free and forced-oscillation characteristics are studied. The nonlinear nature of the system manifests itself, in the case of the forced oscillations, as a shift in the dynamic equilibrium position resulting in a loss of mean hoverheight. (Author)

A71-13724 New laboratory requirements for the DC-10. D. B. Engum (Douglas Aircraft Co., St. Louis, Mo.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700829*. 6 p. Members, \$1.00; nonmembers, \$1.50.

Description of the new laboratory facilities required for the DC-10 test program. The test laboratories have been relocated to a new Engineering Development Center providing a large, high-bay test hangar and ready access to an extensive digital and analog computer facility for data reduction and simulation. The new facilities provide a coordinated complex for structural tests, flight guidance and control tests, and flight tests. Structural test techniques have been brought to a high state of refinement through new large fatigue test machines and application of computer-controlled servo loading systems to the aircraft's structural proof and fatigue test programs. M.M.

A71-13725 The Hamilton standard APU for Lockheed's TriStar airliner. Paul G. Stein (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *Society of Automotive*

Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700814. 11 p. Members, \$1.00; nonmembers, \$1.50.

Description of the design and development stages of the Hamilton Standard Auxiliary Power Unit (APU) for the Lockheed TriStar aircraft. The TriStar APU consists of a lightweight, highly efficient free-turbine engine which drives a separate air compressor that is matched to the aircraft pneumatic system, and a gearbox for powering a generator and cooling fan. The free-turbine engine design offers excellent full- or part-load fuel economy and efficiency while operating at high engine-cycle pressure ratios. Concurrently, this APU with its separate load compressor generates lower pneumatic pressures which enhance the operation of the aircraft air conditioning system. These advantages are further amplified by the use of the proven PT6 engine with over 4,300,000 accumulated operating hours to its credit. M.M.

A71-13726 DC-10 test program effectiveness. Arthur Torosian and James F. Murray (Douglas Aircraft Co., St. Louis, Mo.). *Society of Automotive Engineers, National Aeronautic and Space Engineering and Manufacturing Meeting, Los Angeles, Calif., Oct. 5-9, 1970, Paper 700830.* 10 p. Members, \$1.00; nonmembers, \$1.50.

Discussion of DC-10 test program effectiveness, which is defined as the efficient planning, instrumentation, execution, and analysis of engineering development simulator tests and aircraft ground and flight tests. The purpose is to evaluate aircraft performance and flying qualities, to define the operational envelope, to evaluate systems performance, and to demonstrate that the aircraft and its systems comply with airworthiness standards. The flight test program will employ a sophisticated data acquisition and processing system with the capability to provide real-time data while the tests are in progress. A flight controls development test stand will be used to evaluate the prototype flight control and avionics equipment, and provide the capability for pilot assessment of the Flight Guidance and Control System by means of an integrated simulator complex. A laser beam tracking system will be used to provide the space positioning data required in Flight Guidance and Control, noise measurement, and takeoff and landing performance tests. F.R.L.

A71-13730 # Static-pressure probes that are theoretically insensitive to pitch, yaw and Mach number. A. M. O. Smith and A. B. Bauer (Douglas Aircraft Co., Long Beach, Calif.). *Journal of Fluid Mechanics*, vol. 44, Nov. 26, 1970, p. 513-528. Research supported by the Douglas Aircraft Independent Research and Development Program.

The idea of distributing static probe cross-sectional areas so as to render the probe insensitive to Mach number is combined here with that of using noncircular cross-sections to render probes insensitive to yaw and angle of attack. Appropriate noncircular cross-sections are described in detail, and a general means of designing blunt or slender probes to have zero sensitivity to yaw and angle of attack in potential flow is described. Four experimental probes have been tested, and test results are presented. These results show that the probes are quite insensitive to yaw and angle of attack within certain limiting angles, which are assumed to correspond to the onset of flow separation. (Author)

A71-13734 Airworthiness and the Air Registration Board (Twenty-sixth British Commonwealth Lecture). Walter Tye (Air Registration Board, Redhill, Surrey, England). *Aeronautical Journal*, vol. 74, Nov. 1970, p. 873-887. 22 refs.

Summary of the history of the Air Registration Board, and general survey of the civil airworthiness scene, past and present. The aims and objectives of an airworthiness authority and the reasons for national and international control of airworthiness are discussed,

along with the administrative arrangements for control implementation. In particular, the technical changes in airworthiness over the past 25 years are reviewed, together with the main reasons for these changes. M.V.E.

A71-13735 Accident and maintenance recording for civil aircraft. N. O. Matthews (Cranfield Institute of Technology, Cranfield, Beds., England). *Aeronautical Journal*, vol. 74, Nov. 1970, p. 888-897. 7 refs.

Review of present trends of accident and maintenance recording regulations and systems for civil aircraft. Some aspects of recent developments in this field that have taken place mainly in the UK, France, Holland, Scandinavia, Italy, U.S., and Canada are presented. International requirements for accident recorders and, in particular, FAA proposed aircraft flight recorder data specifications are tabulated and discussed, along with recorder types used by civil airlines. Airborne data recording for accident, maintenance, and operational performance is at present on the threshold of change. The integration of airborne data gathering, processing and storing systems with air-to-ground telemetry links is spurred by projected onboard centralized digital computer systems which will also handle engine performance, navigation and automatic landing, and many of the other electronic functions which at present are handled by analog means. M.V.E.

A71-13737 The lift of a slender combination of a fuselage of rectangular cross-section with a high wing. R. D. Andrews (Royal Aircraft Establishment, Farnborough, Hants., England). *Aeronautical Journal*, vol. 74, Nov. 1970, p. 903-906. 8 refs.

Calculation of the lift generated by a slender aircraft whose fuselage has a stationary rectangular cross section at the base. The results also apply to the lift on the portion of a slender body which lies upstream of a station where the fuselage has a stationary, rectangular cross section and where the wing is thin and its surface is parallel to the lower surface of the fuselage. M.V.E.

A71-13738 Behaviour of the vortex sheet at the trailing edge of a lifting wing. K. W. Mangler and J. H. B. Smith (Royal Aircraft Establishment, Farnborough, Hants., England). *Aeronautical Journal*, vol. 74, Nov. 1970, p. 906-908.

Analytical investigation of the behavior of a vortex sheet at the trailing edge of a lifting wing with nonzero trailing edge angle. It is found that the vortex sheet shed from the trailing edge, in inviscid subsonic flow, leaves the trailing edge tangentially to the upper or lower surface, or exceptionally, in an intermediate direction. M.V.E.

A71-13748 Heat transfer in the vicinity of the stagnation point on a permeable surface. V. S. Avduvskii and G. A. Glebov (Moskovskii Aviatsonnyi Institut, Moscow, USSR). (*Inzhenerno-Fizicheskii Zhurnal*, vol. 18, May 1970, p. 777-782.) *Heat Transfer - Soviet Research*, vol. 2, Sept. 1970, p. 171-175. 13 refs. Translation.

Investigation of the flow of a dissociating and partly ionized gas over any arbitrary point on a permeable surface through which different gases are injected into the laminar boundary layer. Attention is given to the influence of gas injection (air-air and nitrogen-nitrogen mixtures) on the value of the convective heat flux at large enthalpies of the oncoming flow and large values of the convective heat flux. The effects of blowing on the radiant heat flux are not considered. Correlational equations are obtained for the heat exchange parameters. T.M.

A71-13766 # 747 flight load survey program. Philip C. Wingrove (Boeing Co., Seattle, Wash.). *Society for Experimental*

Stress Analysis, Fall Meeting, Boston, Mass., Oct. 18-22, 1970, Paper. 19 p.

Description of the flight load survey program conducted on the Boeing Model 747 to determine flight and ground loads within the design envelope. The instrumentation of the airplane, consisting of 318 strain gauge bridges (159 locations with 100% spares) to measure basic airplane loads, and 360 pressure pickups to measure pressure distributions on the wing flaps and flap track fairings, is reviewed. The strain gauge bridge design, installation, calibration, and recording are described. Flight and ground test conditions and methods of data collection, reduction, and analysis are outlined. A resume of test results is also included. O.H.

A71-13781 * # Installation and testing of strain gages for high-temperature aircraft applications. Earl J. Wilson (NASA, Flight Research Center, Edwards, Calif.). *Society for Experimental Stress Analysis, Fall Meeting, Boston, Mass., Oct. 18-22, 1970, Paper.* 22 p. 5 refs.

The techniques under investigation at the NASA Flight Research Center at Edwards, Calif., for making high-temperature strain measurements on aircraft to resolve flight loads are presented. The necessity of an evaluation program to select the optimum strain gage for specific applications, strain-gage-installation procedures, fatigue problems associated with weldable gages, and new strain-measurement concepts are discussed. Data from laboratory tests to determine the performance characteristics of bonded and weldable strain gages for high-temperature applications are presented. (Author)

A71-13823 Internal aerodynamics (Turbomachinery); Royal Society, Conference, Cambridge University, Cambridge, England, July 19-21, 1967, Proceedings. Conference co-sponsored by the Wates Foundation. London, Institution of Mechanical Engineers, 1970. 160 p. \$15.60.

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A survey of the advances in the treatment of the flow in cascades. N. Scholz (M.A.N. Turbomotoren GmbH; München, Technische Universität, Munich, West Germany), p. 20-31, 41-56. 13 refs.

Methods of treating three-dimensional flows in cascades and blade rows. W. R. Hawthorne (Cambridge University, Cambridge, England), p. 32-56. 27 refs.

Computer calculations of the flow in axial compressors. R. Hetherington (Rolls-Royce, Ltd., Derby, England), p. 57-69. 10 refs.

Aspects of transonic flows in cascades. J. Chauvin (Von Kármán Institute for Fluid Dynamics, Rhode-Saint-Genèse, Belgium), p. 70-82, 95. 6 refs.

Transonic flow in the last rotor blade row of a low-pressure steam turbine. H. Meyer (Brown, Boveri et Cie. AG, Baden, Switzerland), p. 83-95.

Rotating stall in axial flow compressors. J. Fabri (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), p. 96-110, 117.

Aerodynamic damping of compressor blades and turbine buckets. R. G. Legendre (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), p. 111-117.

The applicability of similarity parameters to the compressible flow in radial turbo-machines. M. H. Vavra (U.S. Naval Postgraduate School, Monterey, Calif.), p. 118-132, 147-149. 7 refs.

A method for calculating the flow in a centrifugal impeller when entropy gradients are present. W. Jansen (Northern Research and Engineering Corp., Cambridge, Mass.), p. 133-149. 29 refs.

A71-13824 Turbomachinery technology at Pratt and Whitney Aircraft. W. Doll (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). In: *Internal aerodynamics (Turbomachinery); Royal Society, Conference, Cambridge University, Cambridge, England, July 19-21, 1967, Proceedings.*

Conference co-sponsored by the Wates Foundation. London, Institution of Mechanical Engineers, 1970, p. 3-8.

Review of turbomachinery research and development made at Pratt and Whitney Aircraft to improve the performance of aircraft gas turbine engines. The history and present state of work in this field are outlined. Special attention is given to current component and engine performance trends. Further growth of this industry with a very severe competition in turboengine performance improvement is envisaged. V.Z.

A71-13825 Some thoughts on axial flow compressors. A. G. Newton (Rolls-Royce, Ltd., Derby, England). In: *Internal aerodynamics (Turbomachinery); Royal Society, Conference, Cambridge University, Cambridge, England, July 19-21, 1967, Proceedings.* Conference co-sponsored by the Wates Foundation. London, Institution of Mechanical Engineers, 1970, p. 9-13.

Review of current problems of axial flow compressor designs, noting the considerable progress reached in the improvement of turbomachinery performance at reasonable cost. The highly competitive nature of this industry is emphasized as a factor of prime importance. It is expected that the main further effort will be directed towards an improvement of component efficiency rather than further increases in loading. V.Z.

A71-13826 A survey of the advances in the treatment of the flow in cascades. N. Scholz (M.A.N. Turbomotoren GmbH; München, Technische Universität, Munich, West Germany). In: *Internal aerodynamics (Turbomachinery); Royal Society, Conference, Cambridge University, Cambridge, England, July 19-21, 1967, Proceedings.* Conference co-sponsored by the Wates Foundation. London, Institution of Mechanical Engineers, 1970, p. 20-31; Discussion, K. Barsun (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Braunschweig, West Germany), D. H. Wilkinson (English Electric Co., Whetstone, Leics., England), and D. J. L. Smith (National Gas Turbine Establishment, Farnborough, Hants., England), p. 41-56. 13 refs.

Survey of advances in the theoretical treatment of two-dimensional cascade flows with the aid of high speed computers. Methods of flow field idealization in axial turbomachinery and theoretical methods for calculating two-dimensional cascade flows are reviewed. The application of the exact streamline theory allowing for the blade displacement effects, of the theory of singularities for slender and thick profile geometries, of conformal mapping, and of the relaxation method to studies of incompressible inviscid flows is discussed. Also considered is the treatment of local supersonic flow fields containing terminal shock waves. Other topics include the hodography of duct-type cascades, the hypothesis of streamline similarity, the effect of a boundary layer on a cascade flow, and flow losses in compressible flows. It is also shown how a two-dimensional cascade flow can be corrected when the axial velocity varies within a cascade. V.Z.

A71-13827 **Methods of treating three-dimensional flows in cascades and blade rows.** W. R. Hawthorne (Cambridge University, Cambridge, England). In: Internal aerodynamics (Turbomachinery); Royal Society, Conference, Cambridge University, Cambridge, England, July 19-21, 1967, Proceedings. Conference co-sponsored by the Wates Foundation. London, Institution of Mechanical Engineers, 1970, p. 32-40; Discussion, K. Barsun (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Braunschweig, West Germany), D. H. Wilkinson (English Electric Co., Whetstone, Leics., England), and D. J. L. Smith (National Gas Turbine Establishment, Farnborough, Hants., England), p. 41-56. 27 refs.

Discussion of the present state of the theory of three-dimensional flows in cascades and blade rows. The topics include the three-dimensional effects involved, a potential flow through annular cascades, flows with shear and disturbance, annular cascades in shear flows, and flow approximations. The existing methods of studying three-dimensional flows in cascades are assessed as inadequately approximate. Proof of the validity of the approximations and their improvement are shown to be required. Satisfactory theoretical developments to this end are not expected to be forthcoming for some time. Simplified studies are urged to provide guidance for the correlation of experimental results. V.Z.

A71-13828 **Computer calculations of the flow in axial compressors.** R. Hetherington (Rolls-Royce, Ltd., Derby, England). In: Internal aerodynamics (Turbomachinery); Royal Society, Conference, Cambridge University, Cambridge, England, July 19-21, 1967, Proceedings. Conference co-sponsored by the Wates Foundation. London, Institution of Mechanical Engineers, 1970, p. 57-63; Discussion, P. E. Hubble (Bristol Siddeley Engines, Ltd., Bristol, England), W. Richter (M.A.N. Turbomotoren GmbH, Munich, West Germany), and J. F. Barnes (National Gas Turbine Establishment, Farnborough, Hants., England), p. 64-69. 10 refs.

Evaluation of the effectiveness of computer calculations of flow characteristics in axial compressors. Special attention is given to the r-z problem involving a through flow model in which a swirling flow passes through an annular duct, and the characteristic point within the compressor is described by two variables, r (radius) and z (axial position). Various applications of the through flow method are discussed, including the prediction of compressor performance, the determination of flow curvature effects, and the matching of multistage compressors. Computer applications in axial compressor designs are shown to provide more accurate calculations than calculations available previously. V.Z.

A71-13829 **Aspects of transonic flows in cascades.** J. Chauvin (Von Kármán Institute for Fluid Dynamics, Rhode-Saint-Genèse, Belgium). In: Internal aerodynamics (Turbomachinery); Royal Society, Conference, Cambridge University, Cambridge, England, July 19-21, 1967, Proceedings. Conference co-sponsored by the Wates Foundation. London, Institution of Mechanical Engineers, 1970, p. 70-82; Discussion, A. Smith (C. A. Parsons and Co., Ltd., Newcastle-upon-Tyne, England) and H. Meyer (Brown, Boveri et Cie. AG, Baden, Switzerland), p. 95. 6 refs.

Examination of some available cascade test results in order to obtain data on the blade section performance in transonic and supersonic axial flow compressors during design and off-design operations. The tests cover high turning and tandem bladings, blunt-trailing-edge stator bladings, slotted blades, and blades with constantly diverging passages and thick trailing edges. The topics also include the limitation of cascade testing, the test procedure, performance losses from various causes, the energy exchange correlation, and means of improving performance. V.Z.

A71-13830 **The applicability of similarity parameters to the compressible flow in radial turbo-machines.** M. H. Vavra (U.S. Naval Postgraduate School, Monterey, Calif.). In: Internal aero-

dynamics (Turbomachinery); Royal Society, Conference, Cambridge University, Cambridge, England, July 19-21, 1967, Proceedings.

Conference co-sponsored by the Wates Foundation. London, Institution of Mechanical Engineers, 1970, p. 118-132; Discussion, J. F. Barnes (National Gas Turbine Establishment, Farnborough, Hants., England), C. Schreck (Berlin, Technische Universität, Berlin, West Germany), and M. G. Hodkinson (Austin Motor Co., Birmingham, England), p. 147-149. 7 refs.

Derivation of dimensionless relations to assist the designer of radial turbo-machines with compressible flows. An investigation is carried out to determine if the use of specific speed concepts can augment the available insufficient data on the interdependence between losses and flow channel geometry in radial turbo-machines. It is concluded that specific speed as a parameter does not satisfy the laws of dynamic similarity in turbo-machines with compressible fluids since turbines having the same specific speed can have widely different geometries and different flow properties when the compressibility of the working fluid is taken into account. It is also shown that cascade tests applied to radial machines are of little value and that the outlined chart techniques are more useful as design aids than specific speed criteria. V.Z.

A71-13831 **A method for calculating the flow in a centrifugal impeller when entropy gradients are present.** W. Jansen (Northern Research and Engineering Corp., Cambridge, Mass.). In: Internal aerodynamics (Turbomachinery); Royal Society, Conference, Cambridge University, Cambridge, England, July 19-21, 1967, Proceedings. Conference co-sponsored by the Wates Foundation. London, Institution of Mechanical Engineers, 1970, p. 133-146; Discussion, J. F. Barnes (National Gas Turbine Establishment, Farnborough, Hants., England), C. Schreck (Berlin, Technische Universität, Berlin, West Germany), and M. G. Hodkinson (Austin Motor Co., Birmingham, England), p. 147-149. 29 refs.

Measurements have shown that the velocity distribution at the impeller exit of a centrifugal compressor is often severely distorted. A calculation procedure is presented to predict these distorted flow distributions. The flow field is calculated in two steps. First, the infinite blade solution is obtained with the so-called streamline curvature method. The blade-to-blade solution is obtained afterwards with an approximate method. Flow distortions are assumed to be generated by the occurrence of local losses. These losses are formulated and introduced into the equations of motion by means of entropy gradient terms. The basic ingredients for obtaining the impeller losses are similar to those used in compressor performance prediction methods. Sample calculations are presented for a radial and a backward-curved blade impeller. The procedure yields flow parameters such as velocities, total and static pressures and temperatures, and absolute and relative flow angles along the pressure and suction surface of the blades and across the blade width from hub to shroud. The results are considered to be more realistic than those obtained from existing methods. Possible improvements in flow uniformity by means of design changes are indicated. (Author)

A71-13903 # **The flow of incompressible fluids with Hall effect in the presence of a thin airfoil (L'écoulement des fluides incompressibles à effet Hall en présence d'un profil mince).** L. Dragoș (București Universitatea, Bucharest, Rumania). *Arhivum Mechaniki Stosowanej*, vol. 22, no. 3, 1970, p. 281-290. 10 refs. In French.

Application of previous studies concerning the flow of incompressible fluids with varying electrical resistivity (Sears and Ressler, 1959; Dragoș, 1962, 1963), which demonstrated the harmonic part of the solutions, to fluids with Hall effect. In this fashion it is not only possible to recover, in the most natural way, the previous particular results, but also to show certain structural properties of the solution. The concept that the harmonic part of the solution represents the solution of even the problem of classical aerodynamics is further confirmed. F.R.L.

A71-13956 # Determination of the viscous resistance coefficient of elastically damping supports of turbine engines (Opredelenie koeffitsienta viazkogo soprotivleniia uprugodempfernykh opor turbomashin). E. A. Artemov. *Mashinostroenie*, no. 10, 1970, p. 27-31. 5 refs. In Russian.

Determination of the viscous resistance coefficients of dampers which support the turbine and absorb vibrations by utilizing the viscous resistance of oil. The hydrodynamic damping force is assumed to be equal to the pressure range to which the oil particles are subjected on the entire surface involved in the mass motion. This range is calculated on the basis of equations of motion for an incompressible and unheated Navier-Stokes liquid. The experiments, carried out for checking the theory, are described. Z.W.

A71-14062 # Flows of a viscous emitting gas past blunt bodies (Obtekanie zatuplennykh tel viazkim izluchaiushchim gazom). I. M. Breev, Iu. P. Golovachev, Iu. P. Lun'kin, and F. D. Popov. *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki*, vol. 10, Sept.-Oct. 1970, p. 1228-1237. 14 refs. In Russian.

Application of the Navier-Stokes equations to a study of hypersonic airflows past blunt bodies with allowance for radiation. The radiation term of the energy equation is evaluated with the aid of models which approximate the frequency dependence of the absorption coefficient in the continuous spectrum and in the spectral lines. A solution to the problem is obtained by a finite difference scheme. Profiles of the gasdynamic parameters in the shock layer and the convective and radiative heat fluxes at the surface are determined for a wide range of flight conditions. The shape and position of the shock wave are identified, and the distribution of the heat fluxes and friction coefficients at the nose surface is examined. V.P.

A71-14115 # 2750 deg F engine test of a transpiration air-cooled turbine. S. L. Moskowitz and S. Lombardo (Curtiss-Wright Corp., Wood-Ridge, N.J.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/GT-1*. 11 p. Members, \$1.00; nonmembers, \$2.00.

Test results for a turbine with transpiration air-cooled blades at temperatures ranging from 2750 to 2800 F. The blades were made of alloys limited to metal temperatures of up to 1800 F. The design of the transpiration air-cooled blades is discussed, together with the technique used in fabricating the porous turbine blading. Blading evaluated in the program included airfoil material using N-155 and Nb-stabilized Nichrome V alloy. Both wound and woven types of porous materials were tested. In addition, most blades incorporating woven material had the direction of weave oriented at 45 deg to the forming axis in order to take advantage of the material anisotropy for improved ductility. Correlation of the test results on blade cooling with analytical prediction is presented. Z.W.

A71-14116 # Gas-turbine loading schedule for maximum life of the hot gas path components. Stanislaw Bednarski (General Electric Co., Gas Turbine Dept., Schenectady, N.Y.) and C. N. Shen (Rensselaer Polytechnic Institute, Troy, N.Y.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/GT-2*. 11 p. 11 refs. Members, \$1.00; nonmembers, \$2.00.

The paper describes development of a computational procedure for determining the optimal firing temperature schedule during loading of the gas turbine. It is assumed that the temperature has to be increased in a predetermined time in a way that will minimize thermal fatigue deterioration of the turbine hot gas path elements. The gas temperature is constrained to lie between certain time-dependent limits all through the transient. The maximum plastic strain in a given loading process is taken as a measure of parts deterioration. The calculations performed are for hollow, stationary airfoils of a gas turbine, but the method is easily adaptable to full

profiles and rotational airfoils as well as non-turbine applications where temperature is to be altered while thermal shock is to be minimized. A numerical example is given for illustration of the method. (Author)

A71-14118 # Generalization of experimental data for compressor cascades at low speeds. V. S. Beknev (Moskovskoe Vyshee Tekhnicheskoe Uchilishche, Moscow, USSR). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/GT-10*. 8 p. 9 refs. Members, \$1.00; nonmembers, \$2.00.

The author compares three different approaches for generalization of experimental data for two-dimensional compressor cascades at low speeds: generalization for maximum value of lift-drag ratio, generalization for maximum cascade quality, and generalization for minimum loss coefficient. Some results given, of comparison for incidence and deviation angles, solidities, and loss coefficients, show the largest difference to be for incidence angles and loss coefficients. Influence of isentropic exponent on the airfoil pressure distribution and cascade losses is considered. (Author)

A71-14119 # On the behavior of bladings in the small Reynolds number regime. K. Papailiou and B. Roberts (Von Kármán Institute for Fluid Dynamics, Brussels, Belgium). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/GT-11*. 8 p. Members, \$1.00; nonmembers, \$2.00.

Theoretical calculations using existing correlations can show the advantage of using high aspect ratios for turbine blades, even when one is obliged to work at low Reynolds numbers. For compressor blades this is made possible by using double-circular-arc, blunt trailing edge blades. These blades are proved, experimentally, to show little dependence on Reynolds number effects as far as losses and turning angle are concerned. (Author)

A71-14120 # Some results of fan/compressor noise research. M. J. Benzakein and R. M. Hochheiser (General Electric Co., Cincinnati, Ohio). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/GT-12*. 12 p. 15 refs. Members, \$1.00; nonmembers, \$2.00. Contract No. FA-68-WA-1960.

The paper reviews some research activities on fan/compressor noise currently in progress at the General Electric Company and discusses fan/compressor acoustic scaling procedures. The author describes experimental investigations on the (1) effects of vane/blade ratio and (2) relative advantages of IGV vs no IGV designs in full-scale fans; discusses the results of a parametric study on the effects of vane/blade geometry on transmission through blade rows; and presents a correlation of Sharland's broadband noise prediction with far-field data obtained on a number of full-scale fans. (Author)

A71-14121 # Future trends in aircraft engine noise research. Jervis D. Kester (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/GT-13*. 9 p. 6 refs. Members, \$1.00; nonmembers, \$2.00.

The high bypass ratio engines being introduced into service have generally been acknowledged to provide significant improvement in noise abatement. Substantial improvements in future designs will require research into several areas of engine-component noise generation. Low-noise standards also will be influenced by the aircraft mission requirements that affect selection of the power-plant cycle. Each mission requirement presents special noise problems, which must be solved. This paper explores the relationships among

aircraft mission requirements, noise research in process at Pratt and Whitney Aircraft, and trends predicted for future research. (Author)

A71-14122 # Noise considerations in high bypass ratio fan engine design. A. O. Kohn (General Electric Co., Aircraft Engine Group, Cincinnati, Ohio). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/GT-14.* 9 p. Members, \$1.00; nonmembers, \$2.00.

The General Electric Company is engaged in a number of programs to reduce aircraft-engine noise, ranging from the reheat turbojet for the SST to high bypass ratio lift fans for V/STOL applications. Many of these programs are government-sponsored and have been described elsewhere. The major company-sponsored program is development of the reduced-noise CF6 engine, a design undertaken to achieve a noise level significantly below that of current engines. Analysis and experimental work - done on scale model and engine fans to arrive at the best tradeoff between weight, performance, and noise - resulted in an aerodynamic design that, coupled with development of efficient acoustic treatment of the ducts, has yielded an engine measuring 10 PNdB quieter than current operational engines. The author details three specific technical problem areas (acoustic treatment, turbine noise, and modulation tones) and their impact on CF6 noise. (Author)

A71-14123 * # Some results of recent research on fan and jet noise. Newell D. Sanders (NASA, Lewis Research Center, Special Projects Div., Cleveland, Ohio). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/GT-15.* 6 p. Members, \$1.00; nonmembers, \$2.00.

A 6-ft-dia low-speed fan designed for low-noise production was tested to provide data on noise generation, suppression effects of acoustic treatment, and exhaust jet noise. Preliminary results showed that the overall noise varied with the 5.5 power of the fan speed but was independent of blade loading obtained by varying back pressure at constant speed. The low-velocity jet from the fan produced noise that followed the eighth power law and was lower than predicted by extrapolation of the SAE curve. Modifying the SAE method to eliminate the effects of jet density greatly improved the agreement between prediction and data. (Author)

A71-14133 # Some observations on the velocity profiles in fully developed viscous flow in turbomachines. Shoichi Fujii, Patrick Kavanagh (Iowa State University of Science and Technology, Ames, Iowa), Hideo Nishiwaki, and Mitsuo Gomi (National Aerospace Laboratory, Tokyo, Japan). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/FE-24.* 15 p. Members, \$1.00; nonmembers, \$2.00. Research supported by the Science and Technology Agency and the Iowa State University of Science and Technology.

This paper presents some experimental examples in which the usual radial-equilibrium equation neglecting the local shearing stress is not acceptable, even with streamline curvature, cumulative losses, and total temperature gradients taken into consideration as accurately as possible. The possibility is suggested here that, for improved analysis, the equations of motion should be modified to include local effects of viscosity on the estimation of velocity distributions. This may be true especially in those cases of design of high pressure-ratio multi-stage compressor and in the calculation of compressor off-design performance near the surge point. (Author)

A71-14134 * # Drag force measurements of a compressible turbulent boundary layer on an adiabatic smooth flat plate. Ronald H. Howell (Missouri, University, Rolla, Mo.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/FE-26.* 5 p. 11 refs. Members, \$1.00; nonmembers, \$2.00. Grant No. NSG-13.

The paper presents new measurements of the turbulent skin friction on an adiabatic flat plate with an external flow in the Mach number range of 0.7 and 1 and Re_{θ} in the range of 7500 to 16000. These measurements were obtained during the calibration of a new drag balance designed for measuring drag forces on notches. The new data are compared with two widely accepted prediction methods and a third recently developed method, providing noteworthy agreement in all cases. (Author)

A71-14136 # On the prediction of aerodynamically created sound pressure level of control valves. H. D. Baumann (Masonell International, Inc., Norwood, Mass.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/FE-28.* 13 p. 12 refs. Members, \$1.00; nonmembers, \$2.00.

Recent federal legislation requires combating noise problems, including those of control valves. A proposed empirical method for noise estimation allows a reasonably accurate estimate of the aerodynamically generated sound pressure level (SPL) near a conventional control valve. Tabulated test data show good agreement between theoretical and actual SPL values. Understanding of the parameters that govern the SPL may lead to the design of devices having lower inherent noise levels. Knowledge of the calculated SPL also enables the system design engineer to alter his process conditions or - if this is not possible - to specify special 'low noise' valve types whenever the noise limit is exceeded. (Author)

A71-14137 # Mechanical aspects of gear-induced noise in complete power train systems. Robert H. Badgley (Mechanical Technology, Inc., Latham, N.Y.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/DGP-1.* 8 p. 7 refs. Members, \$1.00; nonmembers, \$2.00. Army-supported research.

Description of a systems analysis approach to the problem of interior helicopter noise, involving a step-by-step consideration of the flow of vibration energy within the drive train. Emphasis is placed on the need for developing precise methods for computing interior noise from design and operating data; it is argued that such methods are more economical than cut and dry techniques for evaluating proposed noise-reduction design changes. In-flight vibration and noise measurements, gathered to form a data bank, are used to assist in understanding the flow of vibration energy and in assessing the adequacy and accuracy of the analytical procedures (comparison of calculated and measured noise spectra). Laboratory experiments on parts of the system are used to study the behavior of critical components. The overall study, directed specifically at UH-1D and CH-47 helicopters, is coordinated and controlled by a comprehensive plan and schedule designed to ensure inclusion of all aspects of the problem. T.M.

A71-14143 # Response and internal noise of a fuselage to random excitation. Thomas J. McDaniel (Dayton, University, Dayton, Ohio). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/DE-9.* 13 p. 20 refs. Members, \$1.00; nonmembers, \$2.00. NSF Grant No. GK-4773.

A coupled air and structure model is developed for predicting the noise radiated into an aircraft fuselage. A procedure complementary to a transfer matrix analysis is used to obtain the frequency response of this closed periodic structure. An analytical model is

used for computing response in the midfrequency range of the structure (100 to 2000 Hz) characterized by half wavelengths between circular frames and by correlated motion of adjacent panels and stringers. An improved transfer matrix for the cylindrical panel using Flügge's shell equations is developed. The effect of additive damping on the noise radiated into the fuselage is investigated.

(Author)

A71-14144 # **Airplane fuselage response to turbulent boundary layers.** J. F. Wilby, W. V. Bhat, and F. L. Gloyna (Boeing Co., Renton, Wash.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/DE-10.* 10 p. 9 refs. Members, \$1.00; nonmembers, \$2.00.

Measurements of turbulent boundary-layer pressure fluctuations and associated structural vibration are presented for an airplane fuselage. The pressure data are similar to published wind tunnel results if allowance is made for fuselage angle of attack. Correlation of the fuselage vibration shows running wave characteristics, with indications of coincidence. The coherence of the vibration field is generally higher than that for the excitation. Structural wavelengths and phase velocities are determined as functions of frequency.

(Author)

A71-14148 # **A criterion for the combustion modes in constant area combustors.** Henry Tao-sze Hsia (United Aircraft Physical Sciences Laboratory, Sunnyvale, Calif.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/Av-4.* 6 p. 5 refs. Members, \$1.00; nonmembers, \$2.00.

A criterion is developed to determine whether (a) supersonic combustion can be achieved in a constant area combustor of an air-breathing engine and (b) a single combustor can be operated in both the subsonic and the supersonic mode of combustion. The analysis, based on one-dimensional conservation equations and thermal choking of the flow stream in a constant area duct, can be applied to ramjet and air-augmented rockets. The criterion is explicitly expressed in a dimensionless parameter which contains various air and flow ratios. The analysis concludes that stable supersonic combustion in a constant area combustor can only be obtained in a narrow range of the dimensionless parameter. For ramjets, supersonic combustion is possible only if the heat release in the combustor does not exceed the stagnation enthalpy of the ingested air.

(Author)

A71-14153 * # **A numerical method for predicting the pressure history of a sonic boom wave incident on arbitrarily oriented plane walls.** B. M. Rao (Texas A & M University, College Station, Tex.) and G. W. Zumwalt (Wichita State University, Wichita, Kan.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/APM-9.* 6 p. 13 refs. Members, \$1.00; nonmembers, \$2.00. Grant No. NGR-37-002-037.

The conservation laws for a plane fluid flow were simplified by the weak wave approximations valid for sonic boom-type waves and applied to a field of mesh points, utilizing the 'artificial viscosity' concept for numerical stability. The numerical analysis was applied to predict the pressure history of the sonic boom wave on the window of a commercial store building in Oklahoma City which was broken during a sonic boom test in 1964. The results were compared with the results of a two-dimensional analytical method which was developed earlier by the authors and which rests on firm physical and mathematical foundations. Agreement was very good. The numerical method is not limited to plane cases but should be capable of extension to three-dimensional transient wave problems. (Author)

A71-14158 # **Low-speed slip flow over a wedge.** K. E. Kasza and W. L. Chow (Illinois, University, Urbana, Ill.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/APM-26.* 7 p. 13 refs. Members, \$1.00; nonmembers, \$2.00.

The problem of low-speed slip flow of a rarefied gas over a wedge has been solved using Meksyn's asymptotic method of integrating the boundary-layer equations. Detailed results are given for slip velocity and developing velocity profiles for various wedge angles. The solution tends far downstream asymptotically to the Falkner and Skan profiles of conventional nonslip flow. In addition, the first correction to the skin friction due to velocity slip is found to be of the order of the first power of the molecular mean free path of the gas.

(Author)

A71-14172 # **On the nonlinear vibrations of free-free beams.** Kuo-Kuang Hu and Philip G. Kirmser (Kansas State University, Manhattan, Kan.). *American Society of Mechanical Engineers, Winter Annual Meeting, New York, N.Y., Nov. 29-Dec. 3, 1970, Paper 70-WA/APM-55.* 6 p. 14 refs. Members, \$1.00; nonmembers, \$2.00.

A nonlinear partial differential equation which describes the natural free-free vibrations of beamlike structures is derived, and then solved approximately by reduction to a nonlinear ordinary differential equation through the use of the Duffing and Ritz-Kantorovich methods. This ordinary differential equation, which is a nonlinear eigenvalue problem, is then solved by perturbation and shooting methods. The solutions show that higher modes of vibration are not possible for the nonlinear vibration.

(Author)

A71-14174 **Erosion by liquids.** F. J. Heymann (Westinghouse Electric Corp., Technology Development Dept., Lester, Pa.). *Machine Design*, vol. 42, Dec. 10, 1970, p. 118-124. 39 refs.

Summary of the present state of knowledge regarding cavitation and liquid impingement giving particular attention to theories that look most promising. The dynamics of erosion are considered, and the occurrence of cavitation as a technological problem is discussed. Details concerning the development of damage are examined, and the principal methods used in erosion testing are described. Factors which provide resistance against erosion are investigated. In conclusion, it is pointed out that with the present state of knowledge, erosion resistance cannot be reliably predicted from independent properties but must be measured in erosion tests.

G.R.

A71-14201 # **The flow of a stratified fluid over a vertical step.** O. K. Jones (Bristol, University, Bristol, England). *Tellus*, vol. 22, no. 5, 1970, p. 481-492. 15 refs.

Long's linearized model is used to study the two-dimensional flow of an incompressible, inviscid and stably stratified fluid over a step of finite height in a long channel bounded above by a rigid, horizontal lid. The height of this lid is varied in an attempt to determine its effect on the flow and the results, which are obtained for a range of values of the Richardson number, are compared with the observation of a glider pilot, Farley, taken in Switzerland in the lee of the Jura plateau.

(Author)

A71-14232 # **Lift and side force acting on a body in a transonic flow.** E. D. Terent'ev. (*Prikladnaia Matematika i Mekhanika*, vol. 34, Mar.-Apr. 1970, p. 324, 325.) *PMM - Journal of Applied Mathematics and Mechanics*, vol. 34, no. 2, 1970, p. 303, 304. Translation.

Determination of the distributions of the lifting force and the side force between the wake behind a body and the transonic external flow. The results are obtained by dividing the lifting and side forces into a component representing the portion of the force

which derives from integrating the momentum flow density tensor over the wake area, and a component representing the portion of the force which derives from integrating the external flow function, and by establishing a relation between these components. It is shown that the distributions obtained hold for both viscous and ideal gas flows. V.P.

A71-14240 Some sectional-drag relationships in linearised wing theory. P. R. Ashill (Cranfield Institute of Technology, Cranfield, Beds., England). *Aeronautical Quarterly*, vol. 21, Nov. 1970, p. 340-354. 15 refs. Research supported by the Ministry of Technology.

Relationships for the sectional drag of wings are derived by using the linearised wing theory. It is suggested that some of these results may prove useful for checking the accuracy of numerical lifting-surface theories and for formulating approximate theories. Two main problems are considered, namely the lifting (no thickness) case and the thickness (zero lift) problem. In both cases, general planform shapes are examined and it is shown that particularly simple results are achieved for planar wings with a spanwise axis of symmetry. (Author)

A71-14241 Lifting wings with mixed (subsonic-supersonic) leading edges. J. H. B. Smith, D. Pierce, and Patricia J. Rossiter (Royal Aircraft Establishment, Farnborough, Hants., England). *Aeronautical Quarterly*, vol. 21, Nov. 1970, p. 355-367.

The linearised theory of supersonic flow is applied to a plane wing with a pointed apex whose leading edge is subsonic near the apex but supersonic further outboard. The change in character of the leading edge may occur either where the edge is kinked or at a point where its slope is continuous. In each case, the theoretical pressure field due to incidence is found to be singular along the downstream, outward-going Mach line through the point at which the edge changes character. The form of the singularity is different for the two cases, and somewhat unexpected. Measurements of the pressure on a plane wing with a curved, mixed leading edge showed no abrupt variation near the Mach line on which the singular behavior was predicted. (Author)

A71-14243 Hypersonic flow with attached shock waves over delta wings. B. A. Woods (Leeds University, Leeds, England). *Aeronautical Quarterly*, vol. 21, Nov. 1970, p. 379-399. 12 refs.

Hypersonic conical flows over delta wings are treated in the thin-shock-layer approximation due to Messiter. The equations are hyperbolic throughout, even in regions where the full equations are elliptic, and have not hitherto been solved for flows with attached shock waves. The concept of the simple wave has been used to construct a class of solutions for such flows; they contain discontinuities in flow variables and shock slope but, for the case of flow over a delta wing with lateral symmetry, agreement with results of numerical solutions of the full equations is good. The method is applied to plane delta wings at yaw, and to wings with anhedral and dihedral. For the flow at the tip of a rectangular wing, it is shown that two distinct solutions may be constructed. (Author)

A71-14246 # Air transport development (Rozwój transportu lotniczego). Dorota Kujawska. *Technika Lotnicza i Astronautyczna*, vol. 25, Sept. 1970, p. 15-17, 27. In Polish.

Analysis of worldwide trends in transport development, with emphasis on the expected impact of growth in the airline industry. Capital investment trends in air transport are examined from the viewpoint of their effects on individual fares and on the traffic volume. The future development of small and medium-sized airline corporations is delineated on the basis of conclusions regarding the rapidly advancing modernization of equipment and facilities. T.M.

A71-14247 # Frequency stabilization systems used in aircraft converters (Układy stabilizacji częstotliwości stosowane w przetwornicach lotniczych). Marian Zieliński. *Technika Lotnicza i Astronautyczna*, vol. 25, Sept. 1970, p. 17-19, 36. In Polish.

Survey of different types of frequency stabilization systems used in aircraft dc-to ac converters employing battery-powered dc motors to run an ac generator. Static and astatic frequency control systems are classified into three general groups according to maximum attainable accuracy. Circuit diagrams and principles of operation are described for (1) a system employing a carbon rod and a centrifugal sensor element, and (2) a single-stage magnetoresonant system with two resonant circuits. T.M.

A71-14251 Theoretical problems of working processes in aircraft engines (Voprosy teorii rabotnikh protsessov aviatsionnykh dvigatelei). Edited by Z. G. Shaikhutdinov and A. M. Akhmedzianov. Ufa, USSR, Ufimskii Aviatsionnyi Institut (Ufimskii Aviatsionnyi Institut, Trudy, no. 10), 1968. 77 p. In Russian.

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Effects of changes in the gas flow parameters during vaporization on the design characteristics of the vaporization process proper (O vlianii izmeneniia parametrov gazovogo potoka pri isparenii na raschetnye kharakteristiki samogo protsessa isparenii). V. M. Klevanskii, A. M. Rusak, and A. Ia. Nadyrshin, p. 3-8.

Study of the vaporization process in a liquid injected into a high temperature supersonic flow (Ob issledovanii protsessa ispareniiia zhidkosti, vprysnutoi v vysokotemperaturnyi sverkhzvukovoi potok). A. M. Rusak, V. M. Klevanskii, and A. Ia. Nadyrshin, p. 9-13.

Shape of a shock wave formed during repeated injection of a liquid into a plane supersonic flow (O forme udarnoi volny, obrazuiushcheisia pri vtorichnoi inzhetsii zhidkosti v ploskii sverkhzvukovoi potok). A. Ia. Nadyrshin, V. M. Klevanskii, A. M. Rusak, and Z. G. Shaikhutdinov, p. 14-19. 9 refs.

Lateral drift of suspended solid particles in a plane supersonic flow past a wall with a step (O bokovom snose vzveshennykh tverdykh chastits v ploskom sverkhzvukovom potoke pri nalichii ustupa u stenki). V. B. Rubtsov and Z. G. Shaikhutdinov, p. 20-24.

Analysis of the effectiveness of a repeated oxidizer injection into the supersonic section of a nozzle (K analizu effektivnosti vtorichnogo vpryska oksislitelja v sverkhzvukovoi chasti sopla). V. A. Kronrod and Z. G. Shaikhutdinov, p. 25-34.

Estimation of influence coefficients by statistical method (Otsenka koeffitsientov vliianiia statisticheskim metodom). A. M. Akhmedzianov, p. 35-40.

Study of the relation between the geometrical dimensions of nozzle system elements and the passage area of a nozzle system (Issledovanie vzaimosvazi geometricheskikh razmerov detaiei soplovogo apparata s velichinai prokhodnoi ploshchadi). M. G. Ziazitdinov, A. M. Akhmedzianov, and B. N. Chizhov, p. 41-47.

Analysis of the effectiveness of various techniques for plotting the parameters of a two-shaft turbojet engine (Analiz effektivnosti razlichnykh sposobov otladki parametrov dvukhval'nogo TRD). V. P. Alatortsev, A. M. Akhmedzianov, and A. S. Tikhonov, p. 48-50.

Assembly for measuring the areas of passage cross sections in the nozzle systems of gas turbine engines (Ustanovka dlia zamera ploshchadei prokhodnykh sechenii soplovykh apparatov GTD). E. G. Gimranov and B. N. Chizhov, p. 51-55.

Effect of the window opening time on the shock wave intensity (Vliianie vremeni otkrytiia okna na intensivnost' volny szhatiia). B. P. Rudoi, p. 56-62. 8 refs.

A71-14252 # Effect of changes in the gas flow parameters during vaporization on the design characteristics of the vaporization process proper (O vlianii izmeneniia parametrov gazovogo potoka pri isparenii na raschetnye kharakteristiki samogo protsessa isparenii). V. M. Klevanskii, A. M. Rusak, and A. Ia. Nadyrshin. In: Theoretical problems of working processes in aircraft engines (Voprosy teorii rabochikh protsessov aviatsionnykh dvigatelei). Edited by Z. G. Shaikhutdinov and A. M. Akhmedzianov. Ufa, USSR, Ufimskii Aviatsionnyi Institut (*Ufimskii Aviatsionnyi Institut, Trudy*, no. 10), 1968, p. 3-8. In Russian.

Theoretical study of the changes occurring in the parameters of a gas flow when a partially vaporized fluid is injected into the flow. It is pointed out that appreciable errors can occur in calculations when the amount of the injected fluid is comparable with the rate of the main gas flow and the effects of the vaporized portion of the injected fluid on the pressure, temperature and rate of the resulting gas-vapor-liquid mixture are not taken into account. Expressions are derived to determine these effects. Diagrams are also plotted to show the difference between the results of calculations when these effects are considered or omitted. V.Z.

A71-14256 # Analysis of the effectiveness of a repeated oxidizer injection into the supersonic section of a nozzle (K analizu effektivnosti vtorichnogo vpryska oksislitel'ia v sverkhzvukovoi chasti sopla). V. A. Kronrod and Z. G. Shaikhutdinov. In: Theoretical problems of working processes in aircraft engines (Voprosy teorii rabochikh protsessov aviatsionnykh dvigatelei). Edited by Z. G. Shaikhutdinov and A. M. Akhmedzianov. Ufa, USSR, Ufimskii Aviatsionnyi Institut (*Ufimskii Aviatsionnyi Institut, Trudy*, no. 10), 1968, p. 25-34. In Russian.

Construction of a theoretical model describing the complete combustion of the wall layer of a liquid jet engine fuel by repeated oxidizer injection into the supersonic section of the jet engine with a Laval nozzle. The effectiveness of this combustion stimulation technique is analyzed in terms of the achieved specific jet engine thrust increments. The model assumes that there is a single-valued relation between the heat and mass deliveries, that the flow is steady, one-dimensional and inviscid, that the combustion products are ideal gases with a constant specific heat and a constant molecular weight, that the outer and inner flows move without mixing, and that the pressure over the nozzle cross section is constant. Good agreement is obtained between the theoretical and experimental results. V.Z.

A71-14257 # Estimation of influence coefficients by statistical method (Otsenka koeffitsientov vlianiia statisticheskim metodom). A. M. Akhmedzianov. In: Theoretical problems of working processes in aircraft engines (Voprosy teorii rabochikh protsessov aviatsionnykh dvigatelei). Edited by Z. G. Shaikhutdinov and A. M. Akhmedzianov. Ufa, USSR, Ufimskii Aviatsionnyi Institut (*Ufimskii Aviatsionnyi Institut, Trudy*, no. 10), 1968, p. 35-40. In Russian.

Application of statistical analysis to the estimation of influence coefficients which characterize the factors causing the deviation of the parameters of individual elements of the gas-air ducts of an aircraft engine from their assigned values. An expression is given to determine these coefficients from a relation between the critical areas in the nozzle systems of first and second turbine cascades and the jet nozzle area. The method facilitates the determination of an influence coefficient when limited experimental data are available. A comparison with other methods suggests the adequacy of this method. V.Z.

A71-14258 # Study of the relation between the geometrical dimensions of nozzle system elements and the passage area of a nozzle system (Issledovanie vzaimosvazi geometricheskikh razmerov detaiei soploвого apparata s velichinai prokhodnoi ploshchadi). M. G. Ziiaitdinov, A. M. Akhmedzianov, and B. N. Chizhov. In: Theoretical problems of working processes in aircraft engines (Voprosy teorii rabochikh protsessov aviatsionnykh dvigatelei). Edited by Z. G. Shaikhutdinov and A. M. Akhmedzianov. Ufa, USSR, Ufimskii Aviatsionnyi Institut (*Ufimskii Aviatsionnyi Institut, Trudy*, no. 10), 1968, p. 41-47. In Russian.

Analysis of the interdependence between the size of nozzle system elements and the area of the passage cross section in a full-size two-cascade gas turbine engine and in a miniaturized gas turbine engine used as a power plant. The deviation of overall nozzle system areas from design when allowances in individual nozzle component geometries are incorporated is discussed. Special attention is given to allowances in the chord length, blade thickness, and blade position angle in the turbine passage cross section. The inverse problem of setting allowances for these parameters from given deviations of nozzle components areas from their assigned values is also considered. V.Z.

A71-14259 # Analysis of the effectiveness of various techniques for plotting the parameters of a two-shaft turbojet engine (Analiz effektivnosti razlichnykh sposobov otdadki parametrov dvukhval'nogo TRD). V. P. Alatorsev, A. M. Akhmedzianov, and A. S. Tikhonov. In: Theoretical problems of working processes in aircraft engines (Voprosy teorii rabochikh protsessov aviatsionnykh dvigatelei). Edited by Z. G. Shaikhutdinov and A. M. Akhmedzianov. Ufa, USSR, Ufimskii Aviatsionnyi Institut (*Ufimskii Aviatsionnyi Institut, Trudy*, no. 10), 1968, p. 48-50. In Russian.

Analysis of the comparative quality of plotting the parameters of a two-shaft turbojet engine by varying (1) the r.p.m. in the low pressure cascade during plotting, or (2) the passage cross section of the jet nozzle, or (3) the areas of the nozzle-system passage cross sections in the first and second cascades of the turbine. These plotting techniques are applied in correcting the thrust, specific fuel consumption, gas temperature and compressor steady performance margin of a turbojet engine of this type. Technique (1) is shown to be more efficient than (2) and (3) in this application. V.Z.

A71-14260 # Assembly for measuring the areas of passage cross sections in the nozzle systems of gas turbine engines (Ustanovka dlia zamera ploshchadei prokhodnykh sechenii soplovykh apparatov GTD). E. G. Gimranov and B. N. Chizhov. In: Theoretical problems of working processes in aircraft engines (Voprosy teorii rabochikh protsessov aviatsionnykh dvigatelei). Edited by Z. G. Shaikhutdinov and A. M. Akhmedzianov. Ufa, USSR, Ufimskii Aviatsionnyi Institut (*Ufimskii Aviatsionnyi Institut, Trudy*, no. 10), 1968, p. 51-55. In Russian.

Description of a technique for measuring the areas of flow passage cross sections in the nozzles of gas turbine engines. The experimental assembly consists of an input section, a gas flowmeter, a system of pipes, and a vacuum pump. The nozzle to be tested is inserted into the main flow duct while the vacuum pump draws ambient air through the system and into the exhaust. The theory of this technique is discussed and the operation of the assembly is analyzed. V.Z.

A71-14273 # **Dynamic decelerators using variable porosity knit fabric and high elongation suspension lines.** Hal E. Brockman (Prodesco, Inc., Perkasi, Pa.) and Jay D. Boone (U.S. Navy, Naval Aerospace Recovery Facility, El Centro, Calif.). *American Institute of Aeronautics and Astronautics, Aerodynamic Deceleration Systems Conference, Dayton, Ohio, Sept. 14-16, 1970, Paper 70-1185.* 8 p. Members, \$1.25; nonmembers, \$2.00.

Description of experimental constructions and test data relative to the use of variable porosity knit fabric and high elongation suspension lines, in attempts to reduce the peak forces encountered in parachute deployment. It is pointed out that parachutes which will perform successfully can be constructed of nylon tricot knit fabric. Further development will be required in order to produce an optimum fabric having reduced permeability at 1/2 in. pressure. Compared to woven fabrics, the knit fabrics have proportionately greater change in permeability, as differential pressure increases. Although the tear strength of the knit fabric is below the minimum requirement of Type I, 1.1 ounce woven fabric, the inherent stretch and permeability characteristics appear to reduce the stresses which cause initiation and propagation of tearing, and thus enable the canopy to function satisfactorily. The high elongation lines will require additional testing to determine their value. M.M.

A71-14298 **Aviation fuels.** Maxwell Smith. Henley-on-Thames, Oxon., England, G. T. Foulis and Co., Ltd., 1970. 526 p. 144 refs. \$36.

A review is given of the current state of knowledge concerning the properties of aviation fuels, difficulties encountered during their storage and handling, and their behavior and misbehavior in service. The fundamental notions concerning basic classes of fuels and engines are presented. The laboratory methods used for testing petroleum products are described, and the role played by rig tests in research and routine testing of fuels is briefly examined. The essential properties of gasoline and turbine fuels are reviewed, including grades and specifications, combustion characteristics, blending, and chemical composition. The problems involved in handling and storage of fuels are discussed, taking into consideration (1) quality control, (2) effects of water, dirt, and surfactants, (3) fire precautions, (4) pressure control, and (5) toxicity. Various problems encountered during the use of fuels in aviation are reviewed. The actual general trends in the development of fuels are discussed, and some special kinds of fuels are described. The book is intended as a reference work for people who are in any way connected with fuels for aircraft or with the oil industry. Z.W.

A71-14323 **Evaluation of fuel soluble corrosion inhibitors by polarization measurements.** L. J. Nestor (U.S. Naval Air Propulsion Test Center, Aeronautical Engine Dept., Trenton, N.J.) and W. Beck (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). *Materials Protection and Performance*, vol. 9, Dec. 1970, p. 25-30. 7 refs.

Utilizing an electrochemical cell, based upon the analog of a droplet of water impinging onto a steel surface, fuel soluble corrosion inhibitors were studied by potentiostatic polarization methods (current-time measurements at fixed potentials). Using N-lauroyl sarcosine in water saturated, depolarized isooctane as the inhibited fuel model, it was concluded that this agent prevented corrosive attack by 0.1N KCl solution. (Author)

A71-14347 # **Calculation of the aerodynamic forces on control surfaces in the subsonic range (Zur Berechnung der Ruderluftkräfte im Unterschallbereich).** H. Freese (Hamburger Flugzeugbau GmbH, Hamburg, West Germany). *Zeitschrift für angewandte Mathematik und Mechanik*, vol. 50, Oct. 1970, p. 633-636. 14 refs. In German.

Investigation of the singularities in the pressure distribution on a harmonically oscillating wing with a control surface in the subsonic

range within the framework of linear lifting surface theory. In particular, the singularities near the edge of the wing are analyzed with the aid of a reflection principle. The pressure in the neighborhood of a singularity is determined with the aid of a coordinate stretching procedure. A.B.K.

A71-14365 # **Stability of a profile of variable thickness in a supersonic flow (Ustoichivost' profil'ia peremennoi tolshchiny v sverkhzvukovom potoke).** R. N. Molodozhnikova. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela*, Sept.-Oct. 1970, p. 176-180. In Russian.

Analysis of the stability of a plane profile and a wedge-shaped profile in a bilateral supersonic air flow. Expressions are derived to determine the stability of a symmetric profile whose thickness varies according to an arbitrary law. The rate of divergence is determined in a system of equations describing the stability of a wedge-shaped profile. The Euler method is used for solving this system. The flutter rates of a wedge-shaped profile in a bilateral supersonic gas flow are shown in diagram form as functions of the bluntness of the profile. V.Z.

A71-14393 # **Scientific problems in the control of flight vehicles (Nauchnye problemy upravleniia letatel'nyimi apparatami).** B. N. Petrov, A. A. Krasovskii, E. P. Popov, and B. V. Raushenbakh. *Akademiia Nauk SSSR, Vestnik*, vol. 40, Nov. 1970, p. 47-52. In Russian.

Survey of currently important theoretical problems associated with further refinement of spacecraft and aircraft control systems. Areas of research considered include the dynamics of automatic control processes, man-machine interface problems, development of new physical and bionics principles for control devices, aircraft traffic control systems, and control system testing methods. Recent developments and expected breakthroughs in each of these general fields are discussed. T.M.

A71-14395 **Statistical description of connection strategies for multiradar surveillance (Statistische Beschreibung von Verknüpfungsstrategien bei der Multi-Radar-Beobachtung).** G. van Keuk and W. Pandikow (Gesellschaft zur Förderung der astrophysikalischen Forschung, Forschungsinstitut für Funk und Mathematik, Werthhoven, West Germany). *Elektronische Datenverarbeitung*, vol. 12, Nov. 1970, p. 473-481. 10 refs. In German.

Study of an automatic radar air space surveillance system in which each radar device is associated with a special track computer in which a monoradar air traffic picture is constructed. At the intersection of several surveillance areas of different radar sets there arises the problem of obtaining a multiradar air traffic picture on the basis of the information supplied by the individual monoradar sets. For this purpose an investigation is made of strategies for connecting tracks from different individual air traffic pictures using statistical methods of the theory of Markov chains. The mathematical expectations of certain properties of the connected tracks are calculated. A.B.K.

A71-14399 # **Technology of aircraft construction (Tekhnologiia samoletostroeniia).** A. L. Abibov, N. M. Miriukov, V. V. Boitsov, V. P. Grigor'ev, S. V. Eliseev, I. A. Zernov, L. A. Konorov, and P. F. Chudarev. Moscow, Izdatel'stvo Mashinostroenie, 1970. 601 p. 59 refs. In Russian.

The theoretical bases of the technology of aircraft construction are outlined, and various technological processes connected with the fabrication of parts and the construction from these parts of units, panels, assemblies, and an entire aircraft (helicopter) are described, as well as processes connected with the deposition of protective coatings, the assembly of systems and equipment, and tests used in serial production. In describing the technological processes, new types of modern equipment (program-controlled machines and

automatic assembly lines) are taken into account, as well as possible methods of mechanization and automation of production. The principles of design of technological processes are described, as well as methods and means of ensuring high quality, reliability, and the required product redundancy. The effect of the design of aircraft on the technological processes of their production is shown, and recommendations are made concerning the design of aircraft parts, units, and assemblies. A.B.K.

A71-14445 * # Hypersonic aerodynamic characteristics of flat delta and caret wing models at high incidence angles. Dhanvada Madhava Rao (National Aeronautical Laboratory, Bangalore, India; NASA, Langley Research Center, Hypersonic Vehicles Div., Hampton, Va.). *Journal of Spacecraft and Rockets*, vol. 7, Dec. 1970, p. 1475, 1476. Research supported by the Ministry of Technology.

Discussion of the results of comparative balance measurements on flat and caret delta wing models undertaken to verify an assumption that the caret wing may prove superior to the conventional delta wing in reentry performance. Lift and drag data for both wing concepts are presented. The difference in terms of maximum lift coefficient is nearly 40% in favor of the caret wing. Flow visualization results obtained serve to explain the superiority of the caret wing force characteristics over the flat delta. G.R.

A71-14449 # A comparison between the method of integral relations and the method of lines as applied to the blunt body problem. Gregory F. Homicz and A. R. George (Cornell University, Ithaca, N.Y.). *Journal of Spacecraft and Rockets*, vol. 7, Dec. 1970, p. 1483, 1484, 6 refs. USAF-supported research.

Investigation of the relative accuracy of the method of integral relations and the method of lines as applied to the problem of a blunt body with detached shock. The results obtained refute the notion that the method of integral relations is necessarily more accurate when only a few strips are employed. The results of both methods agree favorably with each other and 'exact' solutions over a wide range of Mach number even for the one-strip approximation used. In some cases the method of lines even surpasses the method of integral relations in predicting certain aspects of the flow. G.R.

A71-14450 * # Influence of initial flow direction on the turbulent base pressure in supersonic axisymmetric flow. Thomas J. Mueller, Charles R. Hall, Jr. (Notre Dame, University, Notre Dame, Ind.), and Patrick J. Roache (Sandia Laboratories, Albuquerque, N. Mex.). (*American Institute of Aeronautics and Astronautics, Atmospheric Flight Mechanics Conference, Tullahoma, Tenn., May 13-15, 1970, Paper 70-555.*) *Journal of Spacecraft and Rockets*, vol. 7, Dec. 1970, p. 1484-1488. 28 refs. Contract No. AF 33(615)-68-C-1007; Grant No. NsG(T)-65.

The results of an analytical and computational program to extend an existing method of predicting the turbulent base pressure in supersonic axisymmetric flow to include the effect of initial flow direction are presented. Conical afterbodies are considered analytically because of the availability of experimental data for these configurations. The analytical method correctly predicts the effect of initial flow direction on the turbulent base pressure. Good quantitative agreement is obtained between the theory and experimental data for conical boattails. The agreement between the theory and a more limited amount of experimental data for conical flares is not as good; however, the correct trends are obtained. Parametric studies of the influence of afterbody angle and length on the turbulent base pressure for several Mach numbers are presented. The influence of the ratio of specific heats on the turbulent base pressure is also presented. (Author)

A71-14452 # Investigation of high mass ratio, multiple-nozzle, air-ejector systems. W. A. Wright (ARO, Inc., Arnold Air Force Station, Tenn.) and F. Shahrokhi (Tennessee, University, Tullahoma, Tenn.). (*American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 5th, Tullahoma, Tenn., May 18-20, 1970, Paper 70-579.*) *Journal of Spacecraft and Rockets*, vol. 7, Dec. 1970, p. 1489-1491. 7 refs. USAF-sponsored research.

Investigation of jet pump (ejector) operation was extended into the range of high secondary/primary mass ratios, where the secondary (driven) stream mass flow was large relative to the primary (driving) stream. Experimental results showed that ejector operation in this range was feasible although the overall ejector pressure ratios were small. Results compared well with duct mixing theory for subsonic diffusion angles less than 3 degrees. Flow separation in the diffuser at greater diffusion angles prevented the attainment of estimated performance. Internal promotion of turbulent mixing by energizing the secondary stream produced only minor improvement in experimental performances. The commonly used one dimensional analysis, when applied to the high mass ratio ejector system, predicted performance results that were significantly higher than experimental performance. (Author)

A71-14453 # Inaccuracy of nozzle performance predictions resulting from the use of an invalid drag law. C. T. Crowe (Washington State University, Pullman, Wash.). *Journal of Spacecraft and Rockets*, vol. 7, Dec. 1970, p. 1491, 1492. 11 refs. Research supported by the Washington State University.

Discussion of the significance of the drag law in nozzle performance predictions taking into consideration the errors in the predictions which result from using incorrect drag laws. It is found that the drag laws devised before data were available to account for rarefaction effects have not led to large errors in specific impulse predictions. Thus discrepancies between predicted and measured nozzle performance which, in the past, were attributed to lack of knowledge of the particle drag coefficient were likely a result of the still unresolved problem of condensed-phase particle size. G.R.

A71-14526 On the continuity of the auroral oval. Jurgen Buchau, James A. Whalen (USAF, Cambridge Research Laboratories, Bedford, Mass.), and S.-I. Akasofu (Alaska, University, College, Alaska). *Journal of Geophysical Research*, vol. 75, Dec. 1, 1970, p. 7147-7160. 26 refs.

Study of the continuity of the auroral oval using high-speed jet aircraft instrumented for ionospheric research during the winter of 1969-1970. Two flights passed completely around the oval and two flights covered the after-evening half of the oval. It is suggested that the auroral oval is, under moderately disturbed magnetic conditions, a continuous band around the geomagnetic pole. Under quiet conditions, discontinuities in the occurrence of aurora in the oval were observed in the morning, noon, and evening sector. Discontinuities in the morning sector were of temporal nature; the discontinuities in the noon and evening sector could be either temporal or spatial. Z.W.

A71-14559 # Spontaneous condensation in the case of a supersonic flow past a convex corner (O spontannoi kondensatsii pri obtekanii sverkhzvukovym potokom vypuklogo ugla). R. A. Tkachenko. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Sept.-Oct. 1970, p. 73-77. 6 refs. In Russian.

Analysis of the system of equations describing the stationary two-dimensional flow of an inviscid nonheat-conducting gas mixture composed of two components, one of which is subject to condensation. Condensation is assumed to be spontaneous, i.e., the oncoming flow does not contain foreign impurities. A computer solution of the equations is obtained by the method of characteristics for air with a 0.3% addition of water vapor, a free stream Mach number and temperature of 2 and 400 deg K, respectively. The characteristics of such a flow past a corner are determined. V.P.

A71-14560 # Plane transonic flow with a curved compression shock (Ploskoe transvukovoe tachenie iskrivlennym skachkom uplotneniya). I. Bilibosunov and N. Karybekov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Sept.-Oct. 1970, p. 78-83. 5 refs. In Russian.

Analysis of a plane-parallel flow containing a subsonic and a supersonic region separated by a compression shock and a transition line. The shock wave front approaches at a right angle to the transition line, forming a quadrant in the physical plane where the flow velocity is subsonic. In the remaining three quadrants, the particle velocity exceeds the speed of sound, thus making it impossible to study the local characteristics of the velocity field within the classical problem of the termination of the compression shock at the transition line in a local supersonic region. In view of this, the shock front is constructed by a perturbation technique, where the quantities required are expanded into series in a small parameter. V.P.

A71-14561 # Damped natural oscillations of a gas flowing past a straight airfoil lattice (O zatukhaushchikh sobstvennykh kolebaniyakh gaza, obtekaiushchego reshetku plastin). V. B. Kurzin. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Sept.-Oct. 1970, p. 84-88. In Russian.

Analysis of the natural oscillations in a gas flow past a straight airfoil lattice for the Zhukovskii-Chaplygin condition of a finite velocity at the profile trailing edges. In this case, a portion of the energy of the oscillating gas is consumed for the formation of trailing vortices. A solution is obtained by reducing the problem to the derivation of a nontrivial solution of the equation for the amplitude of the nonstationary component of the flow's velocity potential. V.P.

A71-14562 # Flow of two coaxial supersonic jets past a sphere (Obtekanie sfery dvumia soosnymi sverkhzvukovymi struiami). K. G. Savinov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Sept.-Oct. 1970, p. 89-94. 7 refs. In Russian.

Discussion of a parallel but nonuniform supersonic flow (which may be treated as two coaxial jets of an ideal gas) past a sphere. Numerical solutions are obtained, with the aid of a difference analog proposed by Babenko and Rusanov (1865), for velocities of the outer jet higher and lower than those of the inner jet. The principal flow characteristics are determined and analyzed in each case. V.P.

A71-14563 # Second approximation in the problem of strong viscous interaction on thin three-dimensional bodies (Vtoroe priblizhenie v zadache o sil'nom viazkom vzaimodeistvii na tonkikh prostranstvennykh telakh). V. V. Mikhailov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Sept.-Oct. 1970, p. 107-113. 6 refs. In Russian.

Investigation of a hypersonic perfect gas flow past a thin three-dimensional body under conditions of strong viscous interaction. Relations are derived which make it possible to reduce the problem of determining the aerodynamic characteristics of an axisymmetric body to a calculation of a flow past a certain equivalent body of revolution at zero angle of attack. A second approximation for the heat-transfer and drag coefficients is obtained by the method of outer and inner coalescing asymptotic expansions. An estimate is made of the range of applicability and the accuracy of the asymptotic theory on the basis of a comparison with examples of exact numerical calculations. A.B.K.

A71-14566 # Reversibility theory for a wing with arbitrary time dependences (O teoreme obratimosti dlia kryla pri proizvol'nykh zavisimostiakh ot vremeni). S. M. Belotserkovskii. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Sept.-Oct. 1970, p. 132-139. 5 refs. In Russian.

Derivation of an integral relation between the boundary conditions and the corresponding aerodynamic loads on straight and inverted wings. In this case the inverted wing is obtained by reversing the motion of the straight wing relative to the principal translational velocity. It is shown that in the case of arbitrary time dependences all of the overall characteristics of straight wings of any planform can be expressed in terms of the characteristics of the corresponding inverted wings. Formulas are derived which make it possible to determine the lifting force and the moments arising on a deforming wing, including a wing with a deflected aileron and flaps, if the corresponding problems of motion of a rigid inverted wing have been solved. A.B.K.

A71-14568 # Discrete vortices in a plane wake at M sub infinity less than 1 and the unsteady boundary layer near a plate (Diskretnye vikhri v ploskom slede pri M sub infinity less than 1 i nestatsionarnyi pogranichnyi sloi u plastinki). O. M. Kuznetsov, S. G. Popov, and V. V. Feoktistov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Sept.-Oct. 1970, p. 176-180. 12 refs. In Russian.

Study of the formation of discrete vortices in a wind tunnel with a rectangular perforated working section. An unsteady density distribution was created in the wind tunnel above the surface of a flat plate at an angle of attack in a flow with incident Mach numbers of 0.4, 0.6, and 0.8. The Töpler method was employed in this study in a defocused filament scheme and in a schlieren interferometer scheme. The existence of periodic density waves above the surface of the plate at the investigated incident Mach numbers is established. The occurrence of these waves is attributed to discrete vortices and also to sonic pressure pulses propagating in a direction opposite to that of the unperturbed flow. A.B.K.

A71-14571 # Experimental investigation of hypersonic flow past a vibrating body with a skirt (Eksperimental'noe issledovanie obtekaniia giperzvukovym potokom kolebliushchegosia tela s iubkoi). V. I. Lagutin, D. G. Levchuk, and V. N. Shmanenkov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Sept.-Oct. 1970, p. 189-191. 5 refs. In Russian.

Evaluation of the results of an experimental study of hypersonic flow past a freely vibrating hemisphere-cylinder-cone model. It is shown that the nature of the vibrations of the model depends essentially on the Reynolds and Mach numbers and on the aperture angle of the conical stabilizer (skirt). A careful study is made of the flow pattern occurring during hypersonic flow past bodies with skirts. A.B.K.

A71-14572 # Interaction between a supersonic flow and a transverse jet blown through a circular hole in a plate (Vzaimodeistvie sverkhzvukovogo potoka s poperechnoi struei, vduvaemoi cherez krugloe otverstie v plastine). V. S. Avdueskiĭ, K. I. Medvedev, and M. N. Polianskii. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Sept.-Oct. 1970, p. 193-197. In Russian.

Consideration of the flow formed during the interaction between a supersonic flow and a transverse sonic or supersonic jet blown perpendicular to the direction of the main stream through a hole in a flat wall. The special features of supersonic flow past a blown jet are ascertained, and the dependences of the geometrical flow characteristics on the parameters of the incident flow and the blown jet are established. A similarity is noted between separation phenomena in front of solid and jet obstacles. The existence of regions with high pressures and large thermal fluxes in the front part of the separation zone is postulated. A.B.K.

A71-14573 # Numerical calculation of an axisymmetric supersonic overexpanded ideal gas jet (Chislennyi raschet osesimmetricheskoi sverkhzvukovoi pererasshirennoi strui ideal'nogo gaza).

I. M. Vasenin and A. D. Rychkov. *Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza*, Sept.-Oct. 1970, p. 197-200. In Russian.

Calculation of overexpanded supersonic jets, drawing upon the fact that in supersonic flows no propagation of small perturbations occurs upstream. The gas flow region is divided into parts in such a way that at the left- and right-hand boundaries of these parts the flow always remains supersonic. Then each part is calculated in succession, the first part being assumed to be the part lying furthest upstream. The calculation is performed on the basis of the buildup principle, using a finite-difference method which makes it possible to perform a continuous calculation of the shock waves. The shape of the jet boundary is assumed to be unknown and is determined during the solution; for its stable determination an averaging operation similar to the introduction of an artificial surface tension is employed. A.B.K.

A71-14589 # Small aspect ratio wing in a bounded flow of an inviscid fluid (Krylo malogo udlineniia v ogranichenom potoke neviazkoj zhidkosti). V. I. Kholiavko and Iu. F. Usik. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 20, 1970, p. 3-11. In Russian.

Application of slender wing theory to an analysis of a bounded inviscid fluid flow past a two-dimensional small aspect ratio wing. The determination of the aerodynamic characteristics of the wing is reduced to the calculation of the apparent mass of a two-dimensional plate near the surface of separation. The influence of the planform of a wing in a bounded inviscid flow on the lifting-force derivative with respect to the angle of attack is analyzed. It is shown that under the influence of the ground effect, the center of pressure shifts toward the trailing edge and that this shift is most pronounced for a wing of rectangular planform. Approximate formulas for the aerodynamic characteristics of small aspect ratio wings near the ground and near a free surface (the case of a submerged wing) are derived on the basis of exact calculations. V.P.

A71-14590 # Deformable large aspect ratio wing in a bounded fluid (Deformiruemoie krylo bol'shogo udlineniia v ogranichennoi zhidkosti). B. S. Berkovskii. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 20, 1970, p. 12-19. 5 refs. In Russian.

Analysis of the carrying capacity of a slender airfoil deformable according to an unknown law. The two-dimensional integral equation of a deformable airfoil moving in a bounded fluid above a solid surface or under a free surface is approximated by a one-dimensional integrodifferential equation for an elastic large aspect ratio wing. The approximate solution yields a relation for the lift coefficient in the form of the product of the lift coefficient of a rigid wing in a bounded fluid and the elasticity influence function. In limiting cases, the results reduce to solutions previously obtained. V.P.

A71-14591 # Transonic gas flow past a symmetric profile (Obtekanie simmetrichnogo profil'a okolozvukovym potokom gaza). G. F. Sigalov. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 20, 1970, p. 20-24. 11 refs. In Russian.

Application of Panchenkov's (1966) 'total approximation' method to the two-dimensional problem of an unbounded uniform adiabatic transonic flow of an inviscid gas past a symmetric profile. It is shown that Panchenkov's method yields an excellent approximation with appreciably less computational labor than in the case of successive approximation and hodograph methods employed by other investigators. The method is demonstrated by examples involving profiles with sharp and rounded leading edges. V.P.

A71-14592 # Impact of a plane jet of finite thickness against a curvilinear surface (Udar ploskoi strui konechnoi tolshchiny o

krivolineinuiu poverkhnost'). V. N. Zhuravlev. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 20, 1970, p. 25-28. In Russian.

Determination of the flow characteristics near the stagnation point for a plane ideal incompressible fluid jet impinging on a curvilinear surface. The influence of the thickness of the jet and the geometry of the surface on the flow characteristics is analyzed. Good agreement between the theoretical and experimental values for pressure coefficient and the angle corresponding to a zero pressure coefficient is established. V.P.

A71-14593 # Range of practical applicability of linear airfoil theory to the calculation of the aerodynamic characteristics of wings (O predelakh prakticheskogo prilozheniia lineinoi teorii nesushchei poverkhnosti k raschetu aerodinamicheskikh kharakteristik kryl'ev). S. D. Ermolenko and A. V. Rovnykh. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 20, 1970, p. 29-34. 5 refs. In Russian.

Assessment of the range of applicability of linear airfoil theory to the calculation of the aerodynamic characteristics of wings moving near the ground or above water and of high-lift wings. A comparison of calculation on the basis of linear theory with experimental data shows that satisfactory results are limited to very small angles of attack even in the case of large aspect ratio wings. V.P.

A71-14594 # Influence of suction of air from the upper wing surface on the longitudinal controllability of an aircraft (Vliianie otsasyvaniia vozdukh'a s verkhnei poverkhnosti kryla na prodol'nuiu upravliaemost' samoleta). Ia. E. Tkachenko and B. S. Baev. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 20, 1970, p. 35-39. 6 refs. In Russian.

Assessment of the influence suction from the upper surface of the leading edge on longitudinal controllability. The influence of BLC on safety and controllability is evaluated, and the forces applied to the control stick, in the case of deflected flaps, in the presence and absence of BLC are compared. It is shown that suction from the upper wing surface tends to increase the critical angle of attack, thereby increasing the range of operational angles of attack and increasing flight safety in proximity of the ground. V.P.

A71-14595 # Investigation of the takeoff and landing characteristics of short takeoff and landing jet aircraft (STOL) (K voprosu issledovaniia vzletno-posadochnykh kharakteristik reaktivnykh samoletov ukorochennogo vzleta i posadki /SUVP/). V. I. Surus. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 20, 1970, p. 40-44. 10 refs. In Russian.

Discussion of the sucking action of a jet on the takeoff and landing distance of two types of STOL aircraft and of aircraft employing boundary layer control. Approximate formulas for preliminary appraisal of the influence of the sucking action of the jet on the lift and drag coefficients during the takeoff run are proposed. It is shown that the jet can have an unfavorable influence on the takeoff characteristics of a number of STOL configurations, and that in some instances, aircraft employing BLC may be preferable to STOL aircraft. V.P.

A71-14606 # Service life of pin jointed connections with interference pins in the presence of elastoplastic strains in the bore walls (Dolgovechnost' boltovykh soedinenii s natiagom pri uprugoplasticheskikh deformatsiakh stenok otverstii). V. G. Kononenko. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 20, 1970, p. 106-113. 5 refs. In Russian.

Development of an engineering method of determining the amplitude and mean cyclic stresses and to determine the sensitivity of the material to cyclic asymmetry. The service life of a pin jointed connection (with interference pins) can then be calculated from the reduced amplitudes of a symmetric cycle. The method is demonstrated by a practical example. V.P.

A71-14609 # Accuracy of assembling three-dimensional joints using assembly holes (K voprosu o tochnosti sborki prostranstvennykh uzlov po sborochnym otverstiiam). Ia. A. Boborykin. *Samoletostroenie i Tekhnika Vozdushnogo Flota*, no. 20, 1970, p. 146-148. In Russian.

Derivation of an expression for assessing the accuracy of the external outlines of a three-dimensional joint in aircraft construction. New results, useful for obtaining a more accurate description of the occurrence of faults, are obtained on the basis of assumptions which derive from the physical aspects of the assembly process. Methods of determining the admissible tolerances for components are proposed. V.P.

A71-14650 # Area navigation in commuter/taxi operations. Glen A. Gilbert. *National Aviation Trades Association and National Air Transportation Conferences, Joint Annual Convention, Hollywood, Fla., Dec. 7-10, 1970, Paper. 14 p.*

Discussion of challenges requiring action programs if commuter and air taxi services are to expand their contribution to air transport development. It is pointed out that commuter and taxi operators, whether using CTOL, STOL or VTOL aircraft, require maximum flexibility and effectiveness in the use of airports and airspace for most efficient service. Due to the demanding nature of their characteristically short-haul operations, they need the ability to operate with a high degree of freedom from traffic delays and restrictions. The stage has been set for updating the ATC System to meet such requirements. Airborne area navigation equipment provides an important tool in contributing immediately toward the further development of this essential transportation capability. M.M.

A71-14976 Aerospace research and development. Edited by E. A. Steinhoff (USAF, Missile Development Center, Holloman AFB, N. Mex.). Tarzana, Calif., American Astronautical Society (AAS Science and Technology Series. Volume 24), 1970. 500 p. In English and German. \$15.75.

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The role of the technical societies in advancement of science and technology in the space age. B. H. Goethert (Tennessee, University, Tullahoma, Tenn.), p. 18-27.

The influence of space technology on general technological progress and impact on standard of living and economy. E. A. Steinhoff (USAF, Missile Development Center, Holloman AFB, N. Mex.), p. 28-45.

The wind tunnels of the Institute of Aerodynamics of the DFL Braunschweig (Die Windkanäle des Instituts fuer Aerodynamik der DFL Braunschweig). H. Schlichting, p. 46-54.

Ceramic research at the Aerospace Research Laboratories. B. C. Weber, p. 55-70.

Basic research in the space age. H. H. Kurzweg (NASA, Office of Advanced Research and Technology, Washington, D.C.), p. 71-85.

Why jet engines - Past, present, and future of the aeronautical gas turbine (Warum Strahltriebwerke - Vergangenheit, Gegenwart und Zukunft der Luftfahrt-Gasturbine). B. Eckert (Daimler-Benz AG, Stuttgart, West Germany), p. 86-105.

New concepts in the physics of solids. J. N. Plendl (USAF, Cambridge Research Laboratories, Bedford, Mass.), p. 106-199.

A Martian biosphere. H. Strughold (USAF, Aerospace Medical

Div., Brooks AFB, Tex.), p. 200-208.

Gas-to-gas film cooling. E. R. G. Eckert (Minnesota, University, Minneapolis, Minn.), p. 209-228. 8 refs.

Interaction of strong blast waves on slender supersonic bodies. A. Busemann (Colorado, University, Boulder, Colo.) and V. D. Blankenship (Aerospace Corp., San Bernardino, Calif.), p. 229-261. 9 refs.

What is flow acoustics - A heuristic study. G. E. Knausenberger, p. 262-288. (See A71-14980 04-12)

Man-made elf phenomena in the ionosphere and exosphere. H. A. Bomke (U.S. Army, Institute for Exploratory Research, Fort Monmouth, N.J.), p. 289-329. 19 refs.

Analytical investigations of hypersonic flow with non-equilibrium oxygen dissociation around blunt and pointed bodies. R. Hermann, p. 330-373. 23 refs.

Dissipation of fog over runways at airports making use of a mechanical fog dispersal procedure (Nebelbeseitigung ueber Landebahnen auf Flugplaetzen mit Hilfe eines mechanischen Entnebelungs-Verfahrens). U. Schmieschek (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Troisdorf, West Germany), p. 374-387. 9 refs.

A possible explanation of the rotating stall (Eine moegliche Erklarung des rotating Stall). H. Soehngen (Saarland, Universität, Saarbrücken, West Germany), p. 388-395.

Flow modification through space charges. O. M. Stuetzer (Sandia Laboratories, Albuquerque, N. Mex.), p. 396-411. 12 refs.

Supersonic combustion in a thermogasdynamical perceptual representation (Ueberschallverbrennung in thermogasdynamisch anschaulicher Darstellung). O. Lutz, p. 412-427. 7 refs.

Compressible flows with closed streamlines at large Reynolds numbers. K. G. Guderley, p. 428-435.

Compound ceramics. E. Ryshkewitch, p. 436-444.

Aerodynamics of wing-propeller interaction. H. Multhopp (Martin Marietta Corp., Baltimore, Md.), p. 445-457.

On the history of the evolution of the German flight propulsion system altitude test stands (Zur Entwicklungsgeschichte der deutschen Flugtriebwerks-Hoehenpruefstaende). H. Barth (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz-Wahn, West Germany), p. 458-488. 16 refs.

A71-14977 Why jet engines - Past, present, and future of the aeronautical gas turbine (Warum Strahltriebwerke - Vergangenheit, Gegenwart und Zukunft der Luftfahrt-Gasturbine). B. Eckert (Daimler-Benz AG, Stuttgart, West Germany). In: Aerospace research and development.

Edited by E. A. Steinhoff. Tarzana, Calif., American Astronautical Society (AAS Science and Technology Series. Volume 24), 1970, p. 86-105. In German.

Discussion of the advantages of jet propulsion in the aeronautical field taking into consideration an analysis of the factors determining the efficiency of the gas turbine and the piston engine under various conditions. The propulsive efficiencies of a propeller and of a jet are mathematically analyzed, and the superiority of jet propulsion for high flight velocities is shown. The small weight of the gas turbine in comparison to an equivalent piston engine is found to be another advantage. Questions of fuel consumption in relation to flight velocity are investigated. Problems of operating temperatures and cooling for the piston engine and the gas turbine are discussed. Systems of cooling presently in use are considered, and attention is given to new investigations regarding cooling by liquid media such as water and sodium. G.R.

A71-14978 Gas-to-gas film cooling. E. R. G. Eckert (Minnesota, University, Minneapolis, Minn.). In: Aerospace research

and development.

Edited by E. A. Steinhoff. Tarzana, Calif., American Astronautical Society (AAS Science and Technology Series. Volume 24), 1970, p. 209-228. 8 refs. Contract No. Nonr-710(57).

Discussion of the film cooling process and of a new method which permits the study of the influence of variable properties. It is pointed out that film cooling is used extensively in gas turbines, jet engines, and rockets to protect various structural components against the influence of heat gases. The physical processes involved in film cooling are described, and relations by which the performance of this cooling method can be predicted are discussed. The method presented for the study of the influence of variable properties is based on the analogy between heat and mass transfer processes. G.R.

A71-14979 Interaction of strong blast waves on slender supersonic bodies. Adolf Busemann (Colorado, University, Boulder, Colo.) and Victor D. Blankenship (Aerospace Corp., San Bernardino, Calif.). In: Aerospace research and development.

Edited by E. A. Steinhoff. Tarzana, Calif., American Astronautical Society (AAS Science and Technology Series. Volume 24), 1970, p. 229-261. 9 refs.

The transient pressure field produced behind a plane blast wave which encounters a thin supersonic wedge or a slender supersonic cone head-on is theoretically predicted for the higher blast intensities and higher body speeds where the intersection of the plane blast wave with the body bow shock occurs completely inside the so-called Mach reflection region. Previous theoretical works have treated explicitly only the lower region of speeds and intensities where the intersection of blast wave and bow shock occurs outside the Mach reflection region. Adding the proper singularity at this internal intersection, the present analysis uses again the conical flow technique, for eliminating time, the conformal mapping, for furnishing two-dimensional solutions, and the semidifferential approach to render the solutions axially symmetric for the cone. The small pressure perturbations that the thin wedge and the slender cone create along their surfaces are determined. The transient peak values exceed the final steady state pressure. (Author)

A71-14983 Dissipation of fog over runways at airports making use of a mechanical fog dispersal procedure (Nebel-beseitigung ueber Landebahnen auf Flugplaetzen mit Hilfe eines mechanischen Entnebelungs-Verfahrens). U. Schmieschek (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Troisdorf, West Germany). In: Aerospace research and development.

Edited by E. A. Steinhoff. Tarzana, Calif., American Astronautical Society (AAS Science and Technology Series. Volume 24), 1970, p. 374-387. 9 refs. In German.

Discussion of a fog dispersal method for the runways of airports which makes use of a rotating sieve for the removal of the fog particles from the air. The principles of operation of the new device are based on the fact that fog particles in air flowing through a sieve will adhere to the wire of the sieve when they get in contact with it. By rotating the sieve it is possible to bring all fog particles in contact with the wire of the sieve and to remove them from the air. Successful tests of the new approach in the laboratory are reported. A fog dispersal apparatus, which is mounted on a trailer and incorporates in its design the principles considered, is described. Tests which prove the effectiveness of the fog dispersal device are discussed. G.R.

A71-14988 Aerodynamics of wing-propeller interaction. H. Multhopp (Martin Marietta Corp., Baltimore, Md.). In: Aerospace research and development.

Edited by E. A. Steinhoff. Tarzana, Calif., American Astronautical Society (AAS Science and Technology Series. Volume 24), 1970, p. 445-457.

Discussion of the aerodynamics of wing-propeller interaction which was investigated in connection with the development of the Navy's counter insurgency aircraft. The main unknowns in the design

of propeller-driven aircraft for the V/STOL flight range are pointed out. A rough analysis of the most basic effects is considered taking into consideration a review of the momentum change in the flow field that has to be expected as a reaction to the lift that keeps the aircraft airborne. As a result of the investigation it is found that the consequent use of the mean flow deflection angle can help a great deal in evaluating or predicting the lift and drag characteristics of wing-propeller combinations. An inverted V blown tail into which the gas generator exhaust is ducted is a very helpful device for the control of propeller-driven V/STOL aircraft. G.R.

A71-14990 Civil Aviation Safety Centre, Annual Technical Conference, 5th, Beirut, Lebanon, September 29-October 2, 1970, Final Report. Beirut, Civil Aviation Safety Centre, 1970. 237 p.

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Economic trends of air transport in the 1970's - The outlook for the international airlines. R. Heitmeyer (International Air Transport Association, Montreal, Canada). 30 p.

The development concept of pooling of technical resources among airlines - Some practical aspects of technical cooperation. K. Lindenmann (Swissair AG, Kloten, Switzerland). 19 p.

The management and economics of airport operation - Main factors which influence cost efficiency. K. M. McLeod (British Airports Authority, London, England). 14 p.

Airport development and operation in the 70s - A consideration of the changing requirements and their impact on developing countries. I. Varney (Board of Trade, London, England). 14 p.

Accident prevention - A review of current accident trends, precautionary advices, and of the development and application of preventive practices. R. H. Watts (International Civil Aviation Organization, Montreal, Canada). 17 p.

Designing to satisfy the increased demands in flight simulation. F. L. M. Edwards (Redifon, Ltd., London, England). 16 p.

Hijacking and other acts of violence against civil aircraft. S. Toriguian (Civil Aviation Safety Centre, Beirut, Lebanon). 14 p.

A71-14991 # Economic trends of air transport in the 1970's - The outlook for the international airlines. Roderick Heitmeyer (International Air Transport Association, Montreal, Canada). In: Civil Aviation Safety Centre, Annual Technical Conference, 5th, Beirut, Lebanon, September 29-October 2, 1970, Final Report. Beirut, Civil Aviation Safety Centre, 1970. 27 p.; Discussion. 3 p.

Discussion of the more important economic trends, developments, and problems facing the world air transport industry in the 1970s, with particular attention to the international airlines. The average annual growth rates in domestic and international air transport are analyzed for periods from 1964 to 1969 and from 1959 to 1969. It is shown that the tendency was for international traffic to grow at a faster rate than domestic traffic. The contributions of business air travel and tourist travel to the passenger traffic in the past and future are discussed. Taking into account the prospective world socioeconomic and trade developments, the general outlook for air traffic growth of the international airlines to 1980 is found to be encouraging. Z.W.

A71-14992 # The development concept of pooling of technical resources among airlines - Some practical aspects of technical cooperation. K. Lindenmann (Swissair AG, Kloten, Switzerland). In: Civil Aviation Safety Centre, Annual Technical Conference, 5th, Beirut, Lebanon, September 29-October 2, 1970, Final Report.

Beirut, Civil Aviation Safety Centre, 1970. 16 p.;

Discussion. 3 p.

Discussion of problems involved in the pooling of technical resources among different airlines for cutting the investment and maintenance cost of aircraft fleets. As an example, the cooperation between KLM, SAS, SWR, and UTA (KSSU) is discussed. Some most important requirements which must be met for achieving successful technical cooperation are discussed. A hierarchic set of joint working bodies, organized for the implementation of technical cooperation, is described. Some specific problems in technical cooperation are examined, including: (1) expense of management time, (2) technical standards and inspection, (3) common aircraft specifications, manuals, maintenance requirements, and component specifications, and (4) technical information service. Z.W.

A71-14993 # The management and economics of airport operation - Main factors which influence cost efficiency. Keith M. McLeod (British Airports Authority, London, England). In: Civil Aviation Safety Centre, Annual Technical Conference, 5th, Beirut, Lebanon, September 29-October 2, 1970, Final Report.

Beirut, Civil Aviation Safety Centre, 1970. 7 p.;

Discussion. 7 p.

Analysis of a number of common factors affecting the cost efficiency of airports located in different parts of world. Emphasis is placed on the importance of recognizing the need to meet airline requirements for new facilities, including, if necessary, the will to raise airport charges in order to find the money for this purpose. Both operational and cost reasons are given for avoiding marble palaces and matching new facilities to the true needs of the business. Stress is placed on the encouragement of management to manage efficiently by giving them full authority, within defined policies, to pursue the maintenance of satisfactory standards at minimum cost. Z.W.

A71-14994 # Airport development and operation in the 70s - A consideration of the changing requirements and their impact on developing countries. Ian Varney (Board of Trade, London, England). In: Civil Aviation Safety Centre, Annual Technical Conference, 5th, Beirut, Lebanon, September 29-October 2, 1970, Final Report. Beirut, Civil Aviation Safety Centre, 1970. 6 p.;

Discussion. 2 p.

Discussion of some factors which are of particular importance for airport development and operation in the developing countries for the next decade. It is forecast that in the ten years from 1970 to 1980 world scheduled passenger traffic will multiply three times above existing levels. Increasing growth rate of cargo must also be considered. To meet the need for the future, a master plan for airport development is postulated which would anticipate the demands which will be put upon it. Two major considerations arise from this plan: (1) arrangements for financing the development, and (2) the need for a suitable training program to ensure that all facilities are sufficiently operated and effectively managed. A detailed discussion of these requirements is included. Z.W.

A71-14995 # Accident prevention - A review of current accident trends, precautionary advices, and of the development and application of preventive practices. R. H. Watts (International Civil Aviation Organization, Montreal, Canada). In: Civil Aviation Safety Centre, Annual Technical Conference, 5th, Beirut, Lebanon, September 29-October 2, 1970, Final Report. Beirut, Civil Aviation Safety Centre, 1970. 13 p.;

Discussion. 4 p.

Analysis of the causes of aircraft accidents during the last several years, and discussion of preventive practices initiated by ICAO. The significant operational areas involved in the accidents are discussed on the basis of statistical data possessed by ICAO. It is shown that almost half the IMC (instrument meteorological conditions) landing phase accidents occurred in the area of normal landing minima, and almost invariably the accidents occurred when the pilot was

attempting to fly by visual reference. Of the 22% which occurred in worse weather, a significant proportion occurred when the pilot was attempting to fly by visual reference. It is also shown that 62% of the landing phase accidents occurred within 2 n mi of the runway threshold, and 74% within 4 n mi. In addition, 72% of the total of 123 accidents occurred when the aircraft was cleared and had initiated an instrument approach. Some other accident causes are discussed, including rising terrain and fuel exhaustion. A review of the action initiated by ICAO is discussed, including standardization of investigation procedures and techniques, dissemination of information, and analysis of all possible air safety information. Z.W.

A71-14997 # Hijacking and other acts of violence against civil aircraft. Shavarsh Toriguian (Civil Aviation Safety Centre, Beirut, Lebanon). In: Civil Aviation Safety Centre, Annual Technical Conference, 5th, Beirut, Lebanon, September 29-October 2, 1970, Final Report. Beirut, Civil Aviation Safety Centre, 1970. 10 p.;

Discussion. 4 p.

Discussion of the draft convention prepared by the Legal Committee of ICAO against unlawful seizure of aircraft. The elements of the definition of unlawful seizure of aircraft are examined. The problems of attempt, complicity in aircraft hijacking, and kind of punishment are discussed. The draft makes the jurisdiction compulsory for each contracting state, but the offense of hijacking is not treated as an international crime. The problem of extradition is examined. The case of aircraft used by joint air transport operating organizations or international operating agencies and not registered in any state is discussed. General criticism of the draft convention is included. Z.W.

A71-15017 Avionics - Military and civil. George E. Pickett (U.S. Army, Washington, D.C.). *Signal*, vol. 25, Jan. 1971, p. 13-15.

Survey of the R and D work carried out by the U.S. Army in avionics which may benefit civil aviation. The subjects noted specifically include air-to-ground and air-to-air communication systems with uhf, vhf, and vhf-FM transceivers, intercom systems and automatic low frequency direction finders; various advanced small size and weight antenna designs; satellite navigation equipment; computer-aided air traffic control operations; rotary wing aircraft flight control systems; and advanced steep-approach landing systems. Transfer of these technologies to civil aviation is believed to be possible. V.Z.

A71-15019 Electronic warfare technology. M. Halpern (Maxson Electronics Corp., Great River, N.Y.). *Signal*, vol. 25, Jan. 1971, p. 22-25.

Discussion of the state-of-the-art in the field of electronic warfare technology with a projection of its development in the next decade. The topics include passive electronic warfare systems aimed at the determination of enemy electronic capabilities, including sensors, receivers, airborne platforms, battlefield surveillance and homing and warning systems, and active electronic warfare systems such as jamming devices of various designs and sophistication. A steady trend toward the replacement of thermionic devices with solid state devices is visualized in the next decade. V.Z.

A71-15024 The USAF's inter-theater STOL requirement. J. Philip Geddes (Interavia, Los Angeles, Calif.). *Interavia*, vol. 25, Dec. 1970, p. 1492-1494.

Discussion of the versatility of STOL aircraft, which have demonstrated their utility in supplying an army caught in hostile territory, fighting a guerrilla war. The Lockheed transport aircraft, in its modified STOL (C-130S) version, is described. Its principal design objective is to achieve 600 to 750 m field performance with minimum change to the basic design. DeHavilland Canada's C-8B is described. It is expected to be able to accomplish overhead STOL landings and takeoffs from fields which would be closed to the C-130S. F.R.L.

A71-15025 Wind tunnel measurements on profiles with flaps at medium Reynolds numbers. II (Windkanalmessungen an Profilen mit Klappen bei mittleren Reynoldszahlen. II). D. Althaus (Stuttgart, Universität, Stuttgart, West Germany). *Aero-Revue*, Dec. 1970, p. 726-729. In German.

Discussion of test data obtained from extensive wind tunnel studies of the efficiency of various profiles with flaps at medium Reynolds numbers. Performance characteristics of flaps used as ailerons are examined and the optimum flap thickness and the permissible positive and negative flap movement are determined. In addition, thicknesses of symmetrical profiles with flaps used in tailplanes are discussed. O.H.

A71-15027 # Influence of high-pass filtering on third-order correlation measurements. K. N. Helland (California, University, La Jolla, Calif.) and G. R. Stegen (Colorado State University, Fort Collins, Colo.). *Physics of Fluids*, vol. 13, Dec. 1970, p. 2925-2931. 9 refs. NSF Grant No. GA-849; Contracts No. AF 44(620)-68-C-0010; No. N 0014-68-A-0493-0001.

Experimental investigation of the influence of high-pass filtering on third-order correlations in grid turbulence. The results obtained indicate that, for sufficiently small cutoff frequencies, third-order correlations remain unchanged by high-pass filtering. M.V.E.

A71-15043 Simultaneous measurements of clear air turbulence at the tropopause by high-power radar and instrumented aircraft. K. A. Browning, C. D. Watkins, J. R. Starr (Royal Radar Establishment, Malvern, Worcs., England), and A. McPherson (Royal Aircraft Establishment, Bedford, England). *Nature*, vol. 228, Dec. 12, 1970, p. 1065-1067. 5 refs.

Discussion of observation data of large amplitude Kelvin-Helmholtz billows based on simultaneous measurements obtained by an instrumented aircraft. The large Kelvin-Helmholtz billows observed by radar at a height of almost 11 km are shown to have been associated with clear air turbulence which produced a vertical aircraft acceleration of 0.65 g. M.V.E.

A71-15125 # Investigation of the possibilities of an evaluation of air traffic systems in developing countries with the aid of a benefit-cost-analysis from the point of view of the national economy (Untersuchung der Möglichkeiten einer Volkswirtschaftlichen Bewertung von Luftverkehrssystemen in Entwicklungsländern mit Hilfe der Nutzen-Kosten-Analyse). Klaus L. Haucke. Berlin, Technische Universität, Fakultät für Maschinenwesen, Dr.-Ing. Dissertation, 1969. 267 p. 577 refs. In German.

Study of the possibilities for an evaluation of the economic significance of air traffic systems in developing countries by means of a benefit-cost-analysis taking also into consideration an analysis of the present position of air traffic in developing countries. The structure and the economic significance of air traffic in developing countries are analyzed giving attention also to questions of equipment, airports, and safety. The reasons for an evaluation of traffic infrastructure projects are explored, and the historical development of the benefit-cost-analysis is reviewed. Basic principles and criteria which must be considered in order to answer questions regarding the applicability of the benefit-cost-analysis to air traffic systems are discussed. Problems connected with the determination of the costs involved are investigated. Methods for the evaluation of various possible traffic systems on the basis of the costs and benefits for the national economy are developed. G.R.

A71-15171 * History of NACA/NASA rotating-wing aircraft research, 1915-1970. IV Cont'd. Frederic B. Gustafson (NASA,

Langley Research Center, Hampton, Va.). *VertiFlite*, vol. 16, Dec. 1970, p. 9-11, 30. 9 refs.

Discussion of the history of NACA/NASA rotating-wing aircraft research in the fields of dynamics, rotor loads, and rotor configurations taking also into consideration flying-qualities and terminal-area studies. Studies regarding ground resonance, coupled frequencies, blade flutter, equations of motions, and blade flapping behavior are considered. Research concerning rotor loads and design conditions is described. Maneuver studies are reported. Investigations involving various rotor configurations include work with propeller-type VTOLs, hingeless-rotor configurations, compound helicopters, tilt-rotor configurations, stopped-rotor configurations, and a tail-rotor configuration. G.R.

A71-15204 Association Technique Maritime et Aéronautique, Session, 70th, Paris, France, May 11-15, 1970, Proceedings. Association Technique Maritime et Aéronautique, Bulletin, no. 70, 1970. 689 p. In French.

Contents:

Optimization of a control linkage by the target model method (Optimisation d'une chaîne de commande par la méthode du modèle tangent). P. Barrier (Délégation Ministérielle pour l'Armement, Paris, France) and J. Doreau (Société d'Applications Générales d'Electricité et de Mécanique, Paris, France), p. 303-325.

Aircraft simulation: Goals and methods - Application to the development of one project: 'Concorde' (La simulation des aéronefs: Buts et moyens - Application au développement d'un projet: 'Concorde'). J. Monfort (Délégation Ministérielle pour l'Armement, Paris, France) and J. Pinet (Société Nationale Industrielle Aérospatiale, Paris, France), p. 389-409.

Norsial-V.E.R.A.S. - Modern technology and new structures applied to sustained hypersonic flights (Norsial-V.E.R.A.S. - Technologie moderne et structures nouvelles appliquées aux vols hypersoniques sustentés). G. Leroy (Société Nationale Industrielle Aérospatiale, Paris, France), p. 411-429.

Synchronization experiments with atomic clocks performed at ONERA with a view to improvement of the localization problem (Expériences de synchronisation d'horloges atomiques effectuées à l'O.N.E.R.A. en vue de l'amélioration du problème de localisation). J. Besson (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), p. 613-629. 13 refs.

Studies on the reduction of frictional resistance in hydrodynamics (Recherches sur la réduction de la résistance de frottement en hydrodynamique). D. Fruman (Paris, Université, Orsay, Essonne, France) and P. Sulmont (Nantes, Ecole Nationale Supérieure de Mécanique, Nantes, France), p. 631-646. 26 refs.

Method of the potential of acceleration for calculation of finite supercavitating wings (Méthode du potentiel d'accélération pour le calcul des ailes supercavitantes finies). L. F. Tsen (CNRS, Paris, France) and M. Guilbaud (CNRS, Paris; Centre d'Etudes Aérodynamiques et Thermiques, Poitiers, France), p. 659-673. 20 refs.

A71-15206 Aircraft simulation: Goals and methods - Application to the development of one project: 'Concorde' (La simulation des aéronefs: Buts et moyens - Application au développement d'un projet: 'Concorde'). J. Monfort (Délégation Ministérielle pour l'Armement, Paris, France) and J. Pinet (Société Nationale Industrielle Aérospatiale, Paris, France). (Association Technique Maritime et Aéronautique, Session, 70th, Paris, France, May 11-15, 1970.) Association Technique Maritime et Aéronautique, Bulletin, no. 70, 1970, p. 389-403; Discussion, Maurice Roy, Satre, and Robert Legendre (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), p. 404-409. In French.

Exposition of the reasons which have led to the requirement for flight simulators, followed by description of the general layout of flight simulators. Ground and airborne methods of flight simulation are described and evaluated, and aspects of utilization of the techniques and of the particular problems which they pose are examined. The major simulators in service in France are briefly described. The development of the Concorde program led SNIA and BAC to use simulation techniques intensively. The experience acquired is considerable, and the results are extremely valuable, both in terms of advanced technical planning of the project, and in terms of time saved in research and development. F.R.L.

A71-15207 Norsial-V.E.R.A.S. - Modern technology and new structures applied to sustained hypersonic flights (Norsial-V.E.R.A.S. - Technologie moderne et structures nouvelles appliquées aux vols hypersoniques sustentés). G. Leroy (Société Nationale Industrielle Aérospatiale, Paris, France). (*Association Technique Maritime et Aéronautique, Session, 70th, Paris, France, May 11-15, 1970.*) *Association Technique Maritime et Aéronautique, Bulletin*, no. 70, 1970, p. 411-426; Discussion, Maurice Roy, Robert Legendre (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France), and Ebner, p. 427-429. In French.

Consideration of sandwich metal construction with a welded Norsial corrugated core. Sandwich metal construction provides light weight combined with great strength and rigidity. The fabrication processes are outlined, and particulars of the various alloys used are presented. The application of this material for the structure of VERAS (Experimental Vehicle for Structural and Aerothermodynamic Research) is discussed. F.R.L.

A71-15210 Method of the potential of acceleration for calculation of finite supercavitating wings (Méthode du potentiel d'accélération pour le calcul des ailes supercavitantes finies). L. F. Tsen (CNRS, Paris, France) and M. Guibaud (CNRS, Paris; Centre d'Etudes Aérodynamiques et Thermiques, Poitiers, France). (*Association Technique Maritime et Aéronautique, Session, 70th, Paris, France, May 11-15, 1970.*) *Association Technique Maritime et Aéronautique, Bulletin*, no. 70, 1970, p. 659-671; Discussion, Robert Legendre (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) and P. Sulmont (Nantes, Ecole Nationale Supérieure de Mécanique, Nantes, France), p. 672, 673. 20 refs. In French.

Development of the method of the potential of acceleration for calculation of supercavitating wings of steady finite lengthening in linear theory. The distributions of sources and pressure doublets on the wing and its cavity are broken down in single and regular parts. A method of numerical solution is proposed, assuming constant regular parts on small elements of surface. Examples of the calculation of wings with flat undersurfaces are presented, with a view to determining the influence of lengthening and of cavitation number. The results are compared with those of other methods and with available measurements. F.R.L.

A71-15223 # Fundamentals of aviation automation (Osnovy aviatsionnoi avtomatiki). I. I. Krinetskii. Moscow, Izdatel'stvo Mashinostroenie, 1969. 404 p. 11 refs. In Russian.

The textbook discusses the theory, operation, design, and performance of principal aircraft automatic systems with feedbacks. The topics discussed include automatic control systems used in piston engines, turbojet engines and turboprop engines, and their cooling systems. Also considered are the dynamic aspects of aircraft piloting, automatic navigation systems and automatic air temperature and pressure control systems. Techniques of studying linear and nonlinear automatic control systems are outlined, and the history of the development of aircraft automatic control systems is surveyed. The book is intended as an aid to students of civil aviation institutes. V.Z.

A71-15285 A review of composite propulsion systems. William J. Niemann (USAF, Space and Missile Test Center, Vandenberg AFB, Calif.). In: *Space sciences - Future applications for mankind*; Vandenberg Scientific and Technical Societies Council, Western Space Congress, 1st, Santa Maria, Calif., October 27-29, 1970, Proceedings. Part 1. North Hollywood, Calif., Western Periodicals Co., 1970, p. 112-117. 7 refs.

This library research paper reviews the current literature for unclassified developments in the field of composite propulsion systems. In the introduction of the paper, a short background and history of the development of composite systems is presented. Three basic concepts of composite systems are explained and the definitions of 'Composite' and 'Semi-composite' systems are developed. The body of the paper is concerned with an explanation of the semi-composite Turbo-Ram-Scramjet and three composite systems, the Ejector Ramjet, the Hyperjet and the Bi-liquid Ramjet Rocket. The advantages and disadvantages of each system are compared. The paper concludes with a brief discussion of development problems. (Author)

A71-15301 Inertial guidance for everyone. Samuel P. Altman (System Development Corp., Santa Monica, Calif.). In: *Space sciences - Future applications for mankind*; Vandenberg Scientific and Technical Societies Council, Western Space Congress, 1st, Santa Maria, Calif., October 27-29, 1970, Proceedings. Part 1. North Hollywood, Calif., Western Periodicals Co., 1970, p. 361-375. 12 refs.

Description of a strapdown inertial guidance system for advanced aerospace missions of cosmic-speed vehicles and for low-speed transport in aircraft, marine, and ground applications. It is shown that new and efficient performance of the strapdown computer software is attainable by use of coordinate definition with the quaternion-set (of four Euler parameters), and of state definition of vehicle momentum. The development of the state theory of astrodynamics based on the modern state concepts and transform theory is discussed. The use of the complete state model for general aerospace applications of cosmic-speed vehicles is described. Z.W.

A71-15321 Real time telemetry data relay from an instrumented aircraft. Fred H. Wisely (USAF, Ships and Aircraft Engineering Div., Vandenberg AFB, Calif.). In: *Space sciences - Future applications for mankind*; Vandenberg Scientific and Technical Societies Council, Western Space Congress, 1st, Santa Maria, Calif., October 27-29, 1970, Proceedings. Part 2. North Hollywood, Calif., Western Periodicals Co., 1970, p. 622-647.

This study examines the feasibility of using an instrumented aircraft for receiving and relaying missile data in real time to a land-based telemetry station. The paper also discusses system operation as affected by flame attenuation, telemetry data reception and ground sensor location. In addition, information is provided relating to pre-support validation tests, system operational parameters, telemetry data evaluation results, and future applications. (Author)

A71-15337 Unsteady aerodynamics of manned space vehicles - Past, present, and future. J. Peter Reding and Lars E. Ericsson (Lockheed Missiles and Space Co., Sunnyvale, Calif.). In: *Space sciences - Future applications for mankind*; Vandenberg Scientific and Technical Societies Council, Western Space Congress, 1st, Santa Maria, Calif., October 27-29, 1970, Proceedings. Part 2. North Hollywood, Calif., Western Periodicals Co., 1970, p. 882-893. 27 refs.

Summary of unsteady flow effects that have been handled successfully with the use of quasi-steady theory, with discussion of their application to proposed space shuttle vehicles. The first generation of manned vehicles, the Apollo-Saturn family, was dominated by free wake effects and shock-induced separations. The

space shuttle will not only suffer from these same separated flow effects, but will also be subjected to vortex interference effects, shock impingements, and stall flutter. Thus the dynamicist is required to investigate nearly the entire range of aerodynamic interference effects. It is considered that the same quasi-steady techniques that successfully predicted the Apollo-Saturn dynamics may be modified and extended to deal with the space shuttle problems. F.R.L.

A71-15352 # Automatic method of generating excitation forces in ground tests of an aircraft structure (Méthode automatique d'appropriation des forces d'excitation dans l'essai au sol d'une structure d'avion). Alphonse Deck. (*Congress on Dynamics of Mechanics, Newcastle-upon-Tyne, England, Sept. 15, 16, 1970.*) ONERA, TP no. 870, 1970. 33 p. 15 refs. In French.

Consideration of the possibility of isolating a natural mode of vibration on a complex structure. A brief review is presented of ground vibration test techniques, and a critical examination is made of existing methods of generating excitation forces. A theoretical and experimental study is made of a systematic iterative method of generation, which makes it possible to determine the excitation forces which isolate a mode at its natural frequency and the frequency itself. A planned installation designed to make the process operational is described, as well as a method of analyzing the response of the structure by synchronous sampling. A.B.K.

A71-15354 # Measurement of unsteady air forces of interacting tandem lifting surfaces (Mesures des forces instantanées d'interaction entre surfaces portantes en tandem). Roger Destuynder (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*NATO, AGARD, Symposium on Unsteady Aerodynamic Forces for Aeroelastic Analysis of Interfering Lifting Surfaces, Tonsberg, Norway, Nov. 3, 4, 1970, Paper 9.*) ONERA, TP no. 890, 1970. 13 p. In French.

Results of a series of wind-tunnel tests designed to determine the effect of certain parameters on the aerodynamic interaction between two tandem lifting surfaces. An attempt is made to illustrate the importance of the coupling terms, in order to provide a theoretical explanation of the flutter instabilities occurring on variable-sweep aircraft. The tests were limited to two types of motion - namely, pure translation and pure pitching oscillation of one wing. The model consisted of two rectangular or swept wings whose relative position could be adjusted continuously in both the horizontal and in the vertical direction. Several conclusions are drawn from the test results, and it is shown that the phenomenon of interaction can be important for certain configurations. A.B.K.

A71-15355 # Application of lifting surface theory to wings provided with control surfaces (Application de la théorie de la surface portante à des ailes munies de gouvernes). Bertrand Darras and Roland Dat (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*NATO, AGARD, Symposium on Unsteady Aerodynamic Forces for Aeroelastic Analysis of Interfering Lifting Surfaces, Tonsberg, Norway, Nov. 3, 4, 1970, Paper 13.*) ONERA, TP no. 889, 1970. 15 p. 13 refs. In French.

Consideration of the problem of control surfaces in unsteady subsonic flow. Following a short survey outlining the various approaches used to solve this problem, the particular method developed at ONERA is described. It is based on the exposition of the logarithmic singularity of the pressure field, and on an analysis of the usual matrix solution of the integral equation. This method, the application of which to a rectangular wing has already been described (Dat et al., 1966, 1968), is extended to an arbitrary planform. The experimental and theoretical results obtained for the rectangular wing are compared. F.R.L.

A71-15356 # Representation of a wing by lifting lines - Application to the calculation of the interaction of two wings in tandem (Représentation d'une aile par des lignes portantes -

Application au calcul de l'interaction de deux ailes en tandem). Roland Dat and Yoshio Akamatsu (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*NATO, AGARD, Symposium on Unsteady Aerodynamic Forces for Aeroelastic Analysis of Interfering Lifting Surfaces, Tonsberg, Norway, Nov. 3, 4, 1970, Paper 5.*) ONERA, TP no. 891, 1970. 18 p. 8 refs. In French.

Discussion of a method for treating problems of complex lifting surface configurations involving several surfaces. The simulation of wings by a lattice of lifting lines is shown to provide a suitable method for the computation of unsteady aerodynamic forces acting upon complex configurations involving several lifting surfaces. This method may be considered as a compromise between the 'Doublet Lattice Method,' advantageous for its flexibility, and the direct 'Lifting Surface Method,' yielding more accurate results for a given number of collocation points. A numerical program has been developed for applying this method to wings lying in two parallel planes. Some of the peculiar features of this computation method are discussed, and a few numerical corroborative results are presented. M.V.E.

A71-15357 # Wind tunnel study of aerodynamic interactions induced by drop loads (Etude en soufflerie des interactions aérodynamiques dues aux charges largables). Jean Christophe (ONERA, Modane, Savoie, France) and Jacques Coste (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*NATO, AGARD, Specialist Meeting on Aerodynamic Interference, Silver Spring, Md., Sept. 28-30, 1970, Paper 25.*) ONERA, TP no. 849, 1970. 13 p. 8 refs. In French.

Review of wind tunnel techniques currently used at the Modane Test Center for the investigation of aerodynamic interactions induced by drop loads. Special attention is given to the techniques employed in directly obtaining the trajectories of drop loads and microrocket-propelled missiles by high-speed motion-picture photography in the wind tunnel. Results obtained by these techniques are compared with data arrived at by a newly developed alternative method. The latter consists in weighing the load in the aerodynamic field of the aircraft and in reconstructing the trajectory by computation. M.V.E.

A71-15358 # Computation of the aerodynamic interactions between the lifting elements of an aircraft in steady or unsteady supersonic flow (Calcul d'interactions aérodynamiques entre les éléments portants d'un avion en écoulement supersonique stationnaire ou instationnaire). Michel Enselme, Jean-Paul Boisseau, and André Guillois (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). (*NATO, AGARD, Specialist Meeting on Aerodynamic Interference, Silver Spring, Md., Sept. 28-30, 1970, Paper 9.*) ONERA, TP no. 850, 1970. 8 p. 7 refs. In French.

Discussion of analog and digital methods for computing the interactions between aircraft elements in unsteady flow, the case of steady flow being treated as a special case. Previously described fundamentals of analog computation of a lifting complex in steady or unsteady supersonic flow are briefly reviewed. The digital method, then described, is shown to parallel the analog computation procedure in employing an explicit method for computing the solutions of the wave equation. The results obtained by both analog and digital computations pertain to wing-body and wing-pod interactions, as well as to a wing of arbitrary planform in unsteady flow. M.V.E.

A71-15367 # Theoretical distribution of pressures on a slender tail assembly in steady flow (Distribución teórica de presiones sobre una cola esbelta en corriente estacionaria). Juan José Martínez García and José Tomás Díez Roche (Madrid, Universidad, Madrid, Spain). *Ingeniería Aeronáutica y Astronáutica*, vol. 22, May-June 1970, p. 1-13. 10 refs. In Spanish.

Determination of the load distribution on a tail assembly using slender body theory. The general case of a tail assembly in a steady uniform flow is investigated for nonzero angles of attack. The transversal flow around the assembly is determined making use of a

transformation of the Schwarz-Christoffel type. The results are expressed by means of elementary functions. It is pointed out that the results obtained are applicable to other tail assemblies which satisfy the general geometrical conditions of the slender configuration considered. G.R.

A71-15389 Effect of a central hole on fatigue of flat sheet specimens subjected to tension-compression or pulsating tension. Alfred Buch (Technion - Israel Institute of Technology, Haifa, Israel). *International Journal of Fracture Mechanics*, vol. 6, Dec. 1970, p. 427-430. 7 refs.

Comparison of the results obtained by means of a formula given by Switek and Buch (1968) with those of Paterson's (1959) formula with respect to the effect of a central hole on the fatigue of flat sheet specimens. It is shown that the use of Paterson's formula involves large maximum and average errors while in the Switek and Buch formula a single set of constants can be chosen for a group of aircraft materials and reliable results can be obtained for specimens up to 10 in. wide. Z.W.

A71-15394 A look at Lynx. *Flight International*, vol. 98, Dec. 10, 1970, p. 908-912.

Description and discussion of the Westland WG.13 Lynx helicopter, which is outwardly a conventional design, but nevertheless displays many advanced features. As a battlefield aircraft, the Lynx provides seating for up to 12 fully armed troops; it can carry three stretchers, each with an attendant, and can carry internally loads of up to 2738 lb. It can be used for antisubmarine warfare. A completely new engine, transmission, and rotor system is described. The free-turbine Rolls-Royce BS.360-07-26 has a rated power of 900 shp. Glass fiber is used extensively throughout the airframe. Various modifications and adaptations to make the helicopter suitable for its varied roles in British and French service are described. F.R.L.

A71-15401 American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 434 p. \$8.00.

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Design considerations for tilt-rotor VTOL aircraft to minimize the effects of the recirculating downwash environment. R. R. Pruyn and R. B. Taylor (Boeing Co., Philadelphia, Pa.). 8 p. 7 refs.

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Flight test noise measurements of a UH-1B helicopter. T. D. Evans and W. E. Nettles (U.S. Army, Aviation Materiel Laboratories, Fort Eustis, Va.). 26 p. 24 refs.

The effect of various operating parameters on the noise radiation patterns from a helicopter in forward flight. R. J. Pegg (NASA, Langley Research Center, Hampton, Va.). 13 p.

A study of noise produced by a helicopter rotor-tip vortex interaction. W. S. Shepard and J. R. Wolfe (Mississippi State University, State College, Miss.). 10 p. 5 refs.

Flight operations to minimize helicopter noise. D. Halwes (Bell Helicopter Co., Fort Worth, Tex.). 6 p. 5 refs.

External noise and downwash measurements on the Vought XC-142A. R. N. Hancock (LTV Aerospace Corp., Dallas, Tex.). 5 p.

Effects of modifying a rotor tip vortex by injection on downwash velocities, noise, and airloads. S. A. Rinehart (Rochester Applied Science Associates, Inc., Rochester, N.Y.). 11 p. 6 refs.

Adverse effects of downwash upon man. W. P. Sohane (U.S. Army, Aeromedical Research Laboratory, Fort Rucker, Ala.). 7 p. 34 refs.

Design for safety session.

Design of the helicopter for the lightning environment. H. M. Bartman and M. H. Chopin (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). 18 p. 16 refs.

An investigation of the trailing vortex system generated by a jet-flapped wing operating at high wing lift coefficients. W. J. Schumacher (U.S. Army, Military Academy, West Point, N.Y.). 4 p. 8 refs.

An analytical method to predict ideal H-V boundary and C.D.P. of rotorcraft with special attention to the application of optimizing techniques. M. Komoda (National Aerospace Laboratory, Tokyo, Japan). 10 p. 8 refs.

Transmission reliability through oil monitoring. D. W. Botstiber (Technical Development Co., Glenolden, Pa.). 7 p.

Helicopter structural design for impact survival. J. L. Haley, Jr. (U.S. Army, Board for Aviation Accident Research, Fort Rucker, Ala.). 13 p. 13 refs.

The 'Fenestron' anti-torque ducted fan-design for safety. P. Domanovsky (Vought Helicopter, Inc., Dallas, Tex.). 4 p.

SAVER - A deployable rescue autogyro. J. J. Barzda (Kaman Aerospace Corp., Bloomfield, Conn.). 6 p.

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IFR design requirements for STOL navigation equipment. R. A. Rogers (American Airlines, Inc., Tulsa, Okla.). 6 p.

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Suggested VTOL handling qualities criteria for civil IFR qualifications. R. J. Reschak (Bell Helicopter Co., Fort Worth, Tex.). 8 p. 14 refs.

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Integrated flight path control and surveillance for VTOL operations. H. P. R. Smith and T. K. Vickers. 14 p.

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A review of turbine engine vibration criteria for VTOL aircraft. R. W. Balke (Bell Helicopter Co., Fort Worth, Tex.). 11 p. 7 refs.

Pilot and passenger vibration environment sensitivity. R. Gabel, B. O. Henderson, and D. A. Reed (Boeing Co., Philadelphia, Pa.). 6 p. 9 refs.

Measurements and analysis of vibration ride environments. J. J. Catherine and S. A. Clevenson (NASA, Langley Research Center, Hampton, Va.). 6 p.

Exploratory study of pilot performance during high ambient temperatures/humidity. S. Moreland (U.S. Army, Directorate of Flight Standards and Qualification, St. Louis, Mo.). 17 p. 17 refs.

Design considerations for acceptable cabin noise levels in light helicopters. C. R. Cox (Bell Helicopter Co., Fort Worth, Tex.). 8 p. 6 refs.

Design for environment session.

Environmental effects on Army helicopter flight controls. T. L. House and D. R. Artis (U.S. Army, Aviation Materiel Laboratories, Fort Eustis, Va.). 7 p. 8 refs.

A study of the Army standard hot day. W. G. Bousman (U.S. Army, Directorate of Flight Standards and Qualification, St. Louis, Mo.). 9 p. 14 refs.

Icing induced structural problems. J. R. Stallabrass and R. D. Price (National Research Council, Ottawa, Canada). 5 p.

Requirements and developmental techniques for engine air particle separators in VTOL aircraft. R. S. Darling, G. J. Hogg, and E. H. Staudt (Boeing Co., Philadelphia, Pa.). 16 p. 25 refs.

General guidelines for the design of helicopter engine protection devices. A. H. Suydam (U.S. Navy, Naval Air Test Center, Patuxent River, Md.). 2 p.

Engine erosion prevention - A comparison of four separators. T. E. Elsasser (U.S. Naval Air Propulsion Test Center, Philadelphia, Pa.). 9 p.

Effect of sand and dust erosion on Army small VTOL gas turbine engines. C. E. Vaughn (U.S. Army, Depot Engineering Support Div., Corpus Christi, Tex.). 7 p. 5 refs.

Some snow and ice properties affecting VTOL operation. L. D. Minsk (U.S. Army, Cold Regions Research and Engineering Laboratory, Hanover, N.H.). 6 p. 16 refs.

AH-56A compound helicopter icing spray-rig tests. A. M. Petach, J. B. Werner, and F. R. Mastroly (Lockheed-California Co., Burbank, Calif.). 6 p.

Environmental development of the U.S. Army OH-58A light observation helicopter. M. M. Kawa (Bell Helicopter Co., Fort Worth, Tex.). 16 p.

VTOL landing sites session.

A report on the heliport environment. A. L. Fornoff (Bell Helicopter Co., Fort Worth, Tex.). 4 p.

Federal design criteria for VTOL ports and STOL ports. G. L. Buley (FAA, Washington, D.C.). 4 p.

Public-use heliports, STOLports, V-ports - A cure for congestion. J. R. Howard (Aerospace Industries Association of America, Inc., Washington, D.C.). 4 p.

Effect of the city center environment on VTOL terminal operations. W. M. Hollister (MIT, Cambridge, Mass.), D. A. De Maio, T. Palsson, and J. P. Tymczyszyn. 11 p. 11 refs.

Experiments on pilot visibility from a V/STOL in overwater hover. G. Kurylowich and A. Ritter (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). 12 p. 11 refs.

V/STOL flight evaluation of visual aids in relation to minimum landing area operations. J. A. Johnston (U.S. Army, Edwards AFB, Calif.). 6 p.

A71-15402 # Design for the Army operational environment.

Richard I. Adams (U.S. Army, Aviation Materiel Laboratories, Fort Eustis, Va.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 11 p. 5 refs.

The Army operational environment has taken a significant toll on Army aircraft in Southeast Asia. Failures occurring on our aircraft are causing excessive costs for maintenance, spare parts, and logistics, and are resulting in low aircraft availability. The reason for excessive component failures is largely due to inadequate environmental design and test criteria used during the development phase of our aircraft. Component failure trends indicate that vibration, sand and dust, and the maintenance environment are the elements of the Army operational environment which are taking the heaviest toll. There is an immediate need for the aircraft designer to have available an accurate, quantified definition of the Army operational environment, not only for Southeast Asia but worldwide. The U.S. Army Aviation

Materiel Laboratories (USAAVLABS) has an approach to solving this very serious problem under the Reliability and Maintainability Program. Use of this approach will provide a better understanding of the Army operational environment for use during design and testing of future Army aircraft systems. This approach will also provide a basis for correction of some deficiencies existing on current-inventory aircraft. (Author)

A71-15403 # Environmental factors in the design of direct lift V/STOL transport aircraft. T. K. Szelkier (Hawker Siddeley Aviation, Ltd., Hatfield, Herts., England). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 16 p. 9 refs.

Discussion of environmental factors in the design of direct lift transport aircraft giving attention to the civil V/STOL and the military V/STOL. It is pointed out that the designation 'direct lift' encompasses lift engines of both the jet and fan types and the dual purpose cruise/lift engines provided with means for thrust vectoring. Of the two possible forms of direct lift, only fan lift satisfies the civil VTOL requirement for a very low noise level. However, the existing jet lift engines provide a suitable alternative for military designs. The merits of direct lift application to STOL aircraft and differences from V/STOL designs are briefly discussed. G.R.

A71-15404 # Design considerations for tilt-rotor VTOL aircraft to minimize the effects of the recirculating downwash environment. Richard R. Pruyn and Robert B. Taylor (Boeing Co., Vertol Div., Philadelphia, Pa.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 8 p. 7 refs. Contract No. AF 33(615)-69-C-1577.

Aerodynamic environmental disturbance effects resulting from near-hover flight conditions close to the ground have been measured on a 1/10-scale, full-span model. Propeller/rotor blade bending moments, flying qualities data, and flow visualization results are presented. Blade loads caused by ground proximity are shown to be predictable by a semiempirical approach. The implications of these data on the design of tilt-rotor aircraft are deduced. (Author)

A71-15405 # Flight test noise measurements of a UH-1B helicopter. Timothy D. Evans and William E. Nettles (U.S. Army, Aviation Materiel Laboratories, Fort Eustis, Va.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 26 p. 24 refs.

Discussion of some results of a noise measurement test of a UH-1B helicopter conducted with the objective of studying the noise characteristics of this helicopter, with special emphasis on gaining some insight into the various forms in which reduced data can be represented. Several types of data reduction and analysis were investigated. Plots of sound pressure level vs frequency (SPL plots) were obtained using both constant bandwidth and constant percentage bandwidth analyzers. In addition, real time analysis was performed on the data. Plots of sound pressure vs time were also obtained as oscillograph records. These plots provided data for a Fourier analysis and also provided a clear picture of the Doppler shift phenomenon. The prominence of the Doppler shift in the record suggests that an analysis of the sound pressure time history data could provide information on the helicopter's speed and position. A

beat phenomenon associated with the main motor and tail rotor sound sources moving in and out of phase could also be clearly identified on the sound pressure time history plots. A subjective analysis of the recordings was also performed in an attempt to gain a better understanding of the frequency and sound pressure analyses. In addition, several other problems of common character are discussed and some solutions are suggested.

O.H.

A71-15406 * # The effect of various operating parameters on the noise radiation patterns from a helicopter in forward flight. Robert J. Pegg (NASA, Langley Research Center, Hampton, Va.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 13 p.

The in-flight noise radiation pattern and spectra were measured for a small helicopter over a range of rotor speeds, airspeeds, and main rotor thrust values, and for a wide range of distances and azimuth angles. The resulting noise radiation patterns were distorted in the direction of flight. A 20% rotor speed reduction resulted in substantial noise level reductions. On the other hand, a 50% reduction in airspeed and a 17% reduction in main rotor thrust resulted in very little noise reduction.

(Author)

A71-15407 # A study of noise produced by a helicopter rotor-tip vortex interaction. W. Steve Shepard and J. R. Wolfe (Mississippi State University, State College, Miss.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 10 p. 5 refs. Army-supported research.

The impulsive noise associated with helicopter flight is discussed. Experimental measurements of the impulsive noise are presented for a Bell H-13 helicopter. By assuming the impulsive noise is a result of a rotor-tip vortex interaction, a theoretical far field pressure signal is determined for the interaction. The calculated signal is compared on a relative basis with the measured signals. Good agreement is obtained between the analytical and experimental results.

(Author)

A71-15408 # Flight operations to minimize helicopter noise. Dennis Halwes (Bell Helicopter Co., Fort Worth, Tex.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 6 p. 5 refs.

Certain helicopter operating conditions are known to produce higher noise levels than others. Flight test evaluations of various size helicopters are being made to determine which flight conditions cause the higher noise levels. The initial results of these tests have been used to define flight techniques which permit the pilot to avoid generating excessive noise while operating in and out of heliports. With these techniques an operator would be able to use heliports in many areas without violating city noise codes. Test results show that when the helicopter operates without blade slap, the altitude necessary to avoid exceeding noise code limits is one half the altitude necessary with blade slap. If the helicopter flies at the same altitude, the use of quieter operating techniques can reduce the ground area exposed to the same noise level by as much as 75%, and can reduce the required distance between a heliport and a noise-sensitive area boundary line by 50%. These reductions in noise exposure result in greater use of the helicopter's unique capabilities without exposing noise sensitive areas to high noise levels.

(Author)

A71-15409 # External noise and downwash measurements on the Vought XC-142A. R. N. Hancock (LTV Aerospace Corp., Dallas, Tex.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 5 p.

In August 1967 the Vought XC-142A V/STOL aircraft and the Sikorsky HH-53B and HH-3C helicopters were utilized in simulated jungle rescue mission tests at Eglin AFB, Florida. During the tests, noise and downwash measurements were made underneath and to one side of the vehicles for a number of hover heights up to an altitude of 200 feet above ground level. Data gathered for both wooded and clear test sites are summarized in this paper. A few of the problems encountered with microphone wind noise and other instrumentation difficulties are briefly discussed. Downwash measurements indicated that surface velocities well outside the rotor cylinder (90 feet from center) were essentially independent of disk loading. Beneath the aircraft, both turbulence and velocities were slightly higher for the XC-142A which had a disk loading approximately six times that of the helicopters. Average octave band noise levels beneath the vehicles approached 100 db in the audio frequency range. Noise directivity of the main and tail rotors is of prime importance in establishing this upper value near the vehicle. For the helicopters, the maximum occurred close in and beneath the vehicles. For the hover heights investigated, the maximum for the XC-142A occurred about 200 feet out from the center of the vehicle. Levels from all three vehicles were sufficient to interfere with communication and would prove damaging to hearing after a short time unless personnel protection was employed.

(Author)

A71-15410 # Effects of modifying a rotor tip vortex by injection on downwash velocities, noise, and airloads. Stephen A. Rinehart (Rochester Applied Science Associates, Inc., Rochester, N.Y.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 11 p. 6 refs. Contract No. N 00014-69-C-0169.

Numerous research efforts have been conducted by different investigators to alter the characteristics of the tip vortex generated by a helicopter blade in order to alleviate the blade-vortex interaction problem as well as the noise problem associated with impulsive loading. Various approaches have been taken in these investigations including modifications of the loading distribution by taper and twist and altering the blade tip by utilizing porous sections. All of these approaches have not been universally successful for all flight conditions. The present analytical investigation shows that it should be possible to significantly alter the characteristics of the trailing tip vortex for almost all flight conditions in a beneficial manner by injecting an airstream directly into the forming tip vortex. Analytical expressions were developed for the initial and final states of the vortex in order to evaluate the effects of mass flow injection on the vortex strength, swirl velocity distribution, vortex core pressure, vortex core size and the induced drag on the blade.

(Author)

A71-15412 # Design of the helicopter for the lightning environment. Herbert M. Bartman and Matthew H. Chopin (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 18 p. 16 refs.

Experimental study of lightning protection of the helicopter. A series of simulated lightning strike tests were carried out to evaluate lightning effects to helicopter components, rotor blades and hub assemblies, with the objective of determining the vulnerability of

actual full-scale hardware as used on military helicopters. A discussion of natural lightning is presented including characteristic current and voltage levels and probable attachment points to the aircraft. Typical examples of damage as experienced in the tests are then illustrated. Possible lightning protection problems are reviewed. In considering helicopter design, a discussion is presented on recent military specification revisions to deal with the lightning hazard. General features of new-generation helicopters are outlined. O.H.

A71-15413 # An investigation of the trailing vortex system generated by a jet-flapped wing operating at high wing lift coefficients. William J. Schumacher (U.S. Army, Military Academy, West Point, N.Y.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 4 p. 8 refs. Contract No. AF 33(625)-69-C-1165.

The purpose of this investigation was to measure the geometry of the trailing vortex generated behind a jet-flapped wing. Such vortices can pose a serious hazard to aircraft that penetrate them. Previous investigations performed on conventional wings indicate that these vortices persist for some time and have maximum tangential velocities which increase linearly with the lift coefficient. As future aircraft may employ high lift devices such as jet-flapped wings, the vortices generated could be even stronger. Two semispan models of a jet-flapped wing were tested in a subsonic wing tunnel. (Author)

A71-15414 # An analytical method to predict ideal H-V boundary and C.D.P. of rotorcraft with special attention to the application of optimizing techniques. Masaki Komoda (National Aerospace Laboratory, Tokyo, Japan). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 10 p. 8 refs.

An analytical method utilizing the optimizing techniques to estimate the ideal height-velocity (H-V) diagram and the critical decision point (CDP) height is proposed. It is pointed out that the control inputs of pilot to the system equations describing rotorcraft dynamics are obtained as the solution of adequately stated optimizing problem in which final rotor rpm is maximized, or equivalently, height loss is minimized or maximized. Also shown is that the degree of optimality of controls can be evaluated by means of influence functions associated with the optimal trajectories thus obtained. In order to show the applicability of this approach, sample calculations are presented for high hover point and knee point of H-V boundary, and for height loss along a partial power climb-out and rejected takeoff from CDP, while state equations which are linearized with respect to acceleration factors are used for simplicity. A comparison with FAA flight test data as to the high hover point is included. (Author)

A71-15415 # Transmission reliability through oil monitoring. D. W. Botstiber (Technical Development Co., Glenolden, Pa.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 7 p.

Discussion of techniques for detection of impending failure at a stage early enough for providing the possibility of reducing the load or speed to a point where operation may be continued until repairs can be performed. Failures of dynamic parts are generally preceded by localized damage to stressed surfaces, resulting in separation of particles from the stressed material. It is shown how these particles may be isolated and utilized to predict component failure while an adequate number of safe operating hours is still available. M.V.E.

A71-15416 # Helicopter structural design for impact survival. Joseph L. Haley, Jr. (U.S. Army, Board for Aviation Accident Research, Fort Rucker, Ala.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 13 p. 13 refs.

Study of helicopter fuselage crashworthiness in specific crash conditions. To examine the question of how much crashworthy performance is required, a detailed statistical review of existing helicopter crash performance is given, discussed, and analyzed. Based on this analysis, several proposals for improved helicopter fuselage design are presented. They include fuselage profile and cross section, location of heavy masses of the helicopter such as transmissions, engines, and landing gear, and the breakaway of these heavy masses from the fuselage. Finally, minimum helicopter design crash conditions are suggested. O.H.

A71-15417 # The 'Fenestron' anti-torque ducted fan-design for safety. Paul Domanovsky (Vought Helicopter, Inc., Dallas, Tex.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 4 p.

The conventional helicopter antitorque tail rotor has long been a potential safety hazard both on the ground and in flight. A new approach for obtaining antitorque control has been developed in a light helicopter which provides safety and reliability features never before achieved in helicopter design. This new antitorque device is a ducted fan named the 'Fenestron' by the developer, Société Nationale Industrielle Aérospatiale of Marignane, France. The development of the Fenestron, which is now in production, is discussed. Particular attention is given to environmental features of the design including safety, reliability, maintainability, vulnerability and noise features. (Author)

A71-15418 # SAVER - A deployable rescue autogyro. Justin J. Barzda (Kaman Aerospace Corp., Bloomfield, Conn.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 6 p.

To improve chances for safe rescue of crewmen after ejection from a disabled aircraft in combat environs, the U.S. Navy and U.S. Air Force have embarked on a program to develop an Advanced Escape/Rescue Capability (AERCAB) which will provide an independent controlled flight capability for 30 minutes after ejection. Several candidate concepts are being evaluated under funded programs to experimentally demonstrate feasibility. One of these concepts is the Kaman SAVER Aerobac, a compact stowable deployable autogyro vehicle. The Naval Air Development Center, Johnsville, is evaluating SAVER under NADC Contract No. N62269-69-C-0552. The paper describes SAVER's preliminary design and features, presents performance data, and discusses the concept's capabilities, demonstrated feasibility, and future design options. (Author)

A71-15419 # A review of turbine engine vibration criteria for VTOL aircraft. R. W. Balke (Bell Helicopter Co., Fort Worth, Tex.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New

York, American Helicopter Society, Inc., 1970. 11 p. 7 refs.

Comparison of current methods of stating vibration criteria and measuring vibrational phenomena, and proposal of some ways for arriving at more universal and realistic criteria and more standardized methods of measurement. Guides are offered for the design of engine dynamic characteristics for engines destined for VTOL applications. It is shown that research is needed (1) to determine the vibratory levels typical of VTOL missions, and (2) to establish improved and standard design and test practices which will make engines rugged enough to survive longer in VTOL environments. M.V.E.

A71-15420 # Pilot and passenger vibration environment sensitivity. R. Gabel, B. O. Henderson, and D. A. Reed (Boeing Co., Vertol Div., Philadelphia, Pa.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 6 p. 9 refs.

Discussion of the problem of defining realistic criteria for vibration levels compatible with acceptable helicopter cockpit comfort. Available literature on human vibration tests is briefly reviewed, but in nearly all cases little or no correlation can be achieved when applied to the low frequency operating domain of the helicopter. The parameters involved in pilot assessment of cockpit comfort clearly indicate the complexity of the problem. Yet, some work done is shown to lead to suggestions about areas of research required. M.V.E.

A71-15421 * # Measurements and analysis of vibration ride environments. John J. Catherines and Sherman A. Clevenson (NASA, Langley Research Center, Hampton, Va.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 6 p.

Flight vibrations of a STOL aircraft, a CTOL aircraft, and a helicopter have been measured in conjunction with Langley Research Center's ongoing Human Comfort Vibration Program in which the vibration environments of various transportation systems are being studied in relation to human comfort. Instrumentation techniques required to measure vibrations and specialized data reduction procedures have been developed. Acceleration measurements are presented in the form of power spectral density plots, distribution of acceleration magnitudes, and standard deviation values for various phases of flight. Results show that the vibrations of STOL and CTOL aircraft are characterized by low frequency responses, whereas the helicopter experiences higher frequency vibrations due to blade passage. The magnitude of the vibrations for the aircraft was greater in the vertical direction (normal to the flight path) than in the lateral direction. (Author)

A71-15423 # Design considerations for acceptable cabin noise levels in light helicopters. C. R. Cox (Bell Helicopter Co., Fort Worth, Tex.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 8 p. 6 refs.

This paper compares noise levels inside light helicopters with those found in two categories of fixed-wing aircraft. It then discusses design features that influence the light helicopter noise levels, and describes some methods of controlling that noise to improve the interior acoustical environment. It shows that high frequency noises emanating from the main transmission, the engine gearbox, and the

accessories are the most objectionable, and that they are present in the cabin of the helicopter at much higher levels than in the cabins of fixed-wing aircraft. The paper discusses design practices that minimize the noise of each source - particularly those practices concerned with the meshing of types of gearing and gear tooth profiles, the reaction of drive system torsional response, the avoidance of system resonances, the isolation of mechanical vibrations, and the design and location of accessory equipment. The paper shows ways of incorporating soundproofing into the basic structure, and discusses its effectiveness. It also presents the results of an interior design study in which tailored soundproofing treatments are used to meet desired comfort criteria. (Author)

A71-15424 # IFR design requirements for STOL navigation equipment. Robert A. Rogers (American Airlines, Inc., Tulsa, Okla.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 6 p.

American Airlines conducted a 75-hour flight test evaluation of the McDonnell Douglas Model 188 (Breguet 941S) STOL aircraft in the spring of 1969. Simulated airline operations were conducted in the St. Louis, Chicago, and New York metropolitan areas. The basic test objective was to investigate the suitability of this type aircraft as a means of providing large scale STOL passenger service between major city centers. The Model 188 is a 'propulsive lift' STOL aircraft. It is powered by four, interconnected turboprop engines, and is controlled through an integrated flight control system which permits 7-1/2 deg glide slope approaches, 65 knot IAS approach speeds and high maneuverability at low airspeeds. It has a 58-passenger capacity. A great deal of information was obtained on the aircraft, airborne equipment and operational procedures. A major portion of the evaluation included extensive onboard navigation equipment testing and data recording to identify the quantitative and qualitative requirements for a suitable STOL navigation system. Three different area/vertical navigation systems (3D RNAV) and one microwave ILS landing system were selected for evaluation. Each system utilized different combinations of signal inputs, different operating principles, and different display methods. (Author)

A71-15425 # Development of the Bendix/air equipment RDR-1DM radar as an approach aid for helicopters. R. J. van der Harten (KLM Noordzee Helikopters N.V., Schiphol Airport, Netherlands). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 6 p.

Review of the development of the RDR-1DM radar as an approach aid for helicopters. The reasons for, and choice of, the radar system are explained, and the radar-approach operational convenience and experience are discussed, along with some further improvement possibilities envisioned. M.V.E.

A71-15426 # IFR airworthiness standards for VTOL aircraft. Dennis A. Tuck (FAA, Washington, D.C.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 2 p.

Interim standards for helicopter instrument certification were developed a little more than ten years ago. These standards have seen limited use during the ensuing decade, primarily due to a lack of growth in the use of helicopters in the civil systems. IFR certification standards are published in the 'Tentative Standards for Verticraft/Powered Lift Transport Category Aircraft' and are being processed

for proposed rulemaking applicable to FAR 27 and FAR 29. Since there do not exist complete quantitative standards which define minimum acceptable combinations of flying qualities, there will continue to be a major reliance on pilot opinion for certification in this area. It is the opinion of the author that, for a large-scale metropolitan air transit system to be successful, higher levels of safety are essential. (Author)

A71-15427 # Suggested VTOL handling qualities criteria for civil IFR qualifications. Robert J. Reschak (Bell Helicopter Co., Fort Worth, Tex.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 8 p. 14 refs.

Review of the development of civil handling qualities criteria for VTOL aircraft from the original fixed wing criteria to the present interim standards for IFR qualification. The more important points of these interim standards are presented, and industry opinions on specific requirements are summarized. After reviewing the concepts underlying these standards, the requirements are discussed which IFR handling qualities criteria should consider. From these analyses, it is concluded that the suitability of a handling qualities characteristic depends upon pilot abilities. Therefore, to account for these pilot factors, any meaningful handling qualities qualification criterion must include the pilot in the loop. A pilot opinion rating system, based on well defined piloting tasks and levels of precision, is suggested as a feasible method of specifying IFR qualification requirements with the pilot in the loop. M.V.E.

A71-15428 # V/STOL flight director systems. Charles M. Scott, Jr. (Sperry Rand Corp., Sperry Flight Systems Div., Phoenix, Ariz.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 5 p.

In keeping with growing requirements for full instrument flight capability in V/STOL vehicles, development effort has been initiated by Sperry Flight Systems Division to improve the pilot control-display interface. Work has been performed in both the command display area and in testing of various operational flight director modes. This paper describes a three-axis flight director system which provides commands for precise control of helicopter, deflected slipstream STOL, or VTOL attitude and power under instrument conditions to very low ceiling and visibility landings. (Author)

A71-15429 # Integrated flight path control and surveillance for VTOL operations. H. P. Ruffell Smith and T. K. Vickers. In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 14 p.

This paper postulates a number of system concepts for the navigation and traffic control of the types of VTOL commercial transport aircraft which may be available beginning around 1980. The constraints imposed by noise, G forces and turbulent wakes on terminal area flight paths, approach profiles and V-port capacity are described. Several concepts are summarized to meet the requirements of en route navigation, approach guidance, air traffic control and approach monitoring of commercial VTOL operations. (Author)

A71-15430 # Environmental effects on Army helicopter flight controls. Thomas L. House and Donald R. Artis (U.S. Army, Aviation Materiel Laboratories, Fort Eustis, Va.). In: American

Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 7 p. 8 refs.

This paper discusses the effects of the environment on U.S. Army helicopter flight controls and USAAVLABS' efforts to minimize those effects. The effects of sand and dust on equipment service life are discussed, and certain statistics are presented which highlight this problem and show its dominance as the single most damaging element of the environment on equipment. Possible revisions to design and qualification specifications are discussed. It is the authors' contention that no technological barriers exist to solving the problems discussed in this paper. (Author)

A71-15431 # A study of the Army standard hot day. William G. Bousman (U.S. Army, Directorate of Flight Standards and Qualification, St. Louis, Mo.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 9 p. 14 refs.

Study of the Army hot day standard design hover criterion through development of analytical models representing hovering aircraft, cost, climatology, and various features of the operational environment. It was concluded that, although the probability of hover provided insight into various factors affecting design and operation of aircraft, it did not exhibit any inherent feature that would allow the selection of a design hover criterion. The inclusion of cost in the evaluation revealed that an aircraft exhibits a maximum in effectiveness/cost with increasing design altitude (at constant temperature). It was concluded that, if a rotorcraft is to have any tolerance for performance degradation, then a design point of 5500 feet, 95 F represents the low end of the range of design hover conditions. It was also concluded that, if a rotorcraft's probability of hover is to truly be a measure of its effectiveness, then the rotorcraft must exhibit maneuverability at its design point. M.V.E.

A71-15432 # Icing induced structural problems. J. R. Stallabrass and R. D. Price (National Research Council, Ottawa, Canada). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 5 p.

Of major concern when helicopters are operated in icing conditions is the structural damage that may result as a secondary effect of the icing of the rotor blades and other components. This paper reviews these problem areas and urges greater attention to them at an early stage of a helicopter's design. (Author)

A71-15433 # Requirements and developmental techniques for engine air particle separators in VTOL aircraft. Richard S. Darling, George J. Hogg, and Ernst H. Staudt (Boeing Co., Vertol Div., Philadelphia, Pa.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 16 p. 25 refs.

Discussion of three basic developmental techniques for engine air particle separators in VTOL aircraft. These are theoretical design and analysis, bench testing, and flight testing. The applicability and limitations of each technique are described, and the results are evaluated. Emphasis is placed on the importance of all three

techniques in a balanced and coordinated development program. Future requirements are based on four major factors: aircraft mission (the amount of time spent in a contaminated environment); airframe design (location of engine inlet(s) with respect to rotors, podded or in the fuselage); engine design (tolerance to contaminants); and environment (sand or dust concentration, size, shape, and chemical composition). F.R.L.

A71-15434 # General guidelines for the design of helicopter engine protection devices. Alan H. Suydam (U.S. Navy, Naval Air Test Center, Patuxent River, Md.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc.,

1970. 2 p.

Discussion of the design of helicopter engine devices intended to facilitate engine maintenance and promote compatibility of the engine with the rest of the helicopter in addition to engine protection against failure. Three current helicopter engine protection devices are analyzed to demonstrate the deficiencies within the systems themselves and the environmental limitations of each system. M.V.E.

A71-15435 # Engine erosion prevention - A comparison of four separators. Theodore E. Elsasser (U.S. Naval Air Propulsion Test Center, Philadelphia, Pa.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc.,

1970. 9 p.

The Naval Air Propulsion Test Center (NAPTC) has conducted a series of thorough evaluations of several models of static, inertial-type inlet particle separators as part of an overall program to help advance the state-of-the-art of engine foreign object damage prevention. During these evaluations, separators were tested to determine particle separation efficiency, foreign object damage protection, resistance to clogging and inlet pressure loss and distortion. A brief description of the test units and the highlights of the results of this program are presented. (Author)

A71-15436 # Effect of sand and dust erosion on Army small VTOL gas turbine engines. Carl E. Vaughn (U.S. Army, Depot Engineering Support Div., Corpus Christi, Tex.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 7 p. 5 refs.

Over the past decade the Army has lost millions of dollars as a result of FOD (Foreign Object Damage) and sand and dust erosion. This paper will cover only sand and erosion even though in most cases damage is a result of a combination of both. At the present time the Army has more than 12,000 T53 and T55 Lycoming Gas Turbine Engines in its inventory with an average value of about \$76,000.00 an engine. Annually 50% or more of the turbine engines returned to ARADMAC for overhaul or repair have experienced excessive erosion in the inlet section (cold section) of the engine. Severe erosion is experienced on the compressor spool assembly (axial and centrifugal section), compressor housing assembly and the leading edge of the first row of vanes of the air diffuser. Even though sand and dust erosion affect the entire airflow channel of the engine this paper will deal only with the inlet section and some of the approaches that have been taken to combat this problem. (Author)

A71-15437 # Some snow and ice properties affecting VTOL operation. L. D. Minsk (U.S. Army, Cold Regions Research and Engineering Laboratory, Hanover, N.H.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc.,

1970. 6 p. 16 refs.

A number of properties of snow and ice directly influence operational characteristics of aircraft, and in particular VTOLs. The fact that icing conditions are most frequently encountered between 3,000 to 24,000 ft altitude means that the exposure of VTOL to incipient icing conditions will be high, seasonally and geographically. The most serious consequence of icing is the aerodynamic degradation of airfoils, propellers, and rotors. This paper will discuss the mechanism of ice adhesion, laboratory tests of the strength of adhesion of ice to various materials, and methods for reducing the adhesion. However, some other aspects of snow and ice are considered, such as the absorption of radiation by snow and ice, and the electrical properties of ice. (Author)

A71-15438 # AH-56A compound helicopter icing spray-rig tests. A. M. Petach, J. B. Werner, and F. R. Mastrolly (Lockheed-California Co., Burbank, Calif.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc.,

1970. 6 p.

The Lockheed/Army AH-56A 'Cheyenne' rigid-rotor compound helicopter was flown in the Canadian National Research Council (NRC) Helicopter Icing Rig at Ottawa to evaluate the adequacy of the vehicle's ice protection systems and to determine any vehicle operation limitations under icing conditions. All vehicle ice protection systems functioned satisfactorily, with no vehicle operation limitations noted. All heated areas (engine inlet and bellmouth, windshield and engine torque shaft and free-turbine-speed signal strut covers) remained essentially ice free even after 30-minute exposure to FAR continuous maximum icing conditions. It was demonstrated that ice buildups on the unheated main rotor blades are kept at a minimum by periodic small rapid cyclic inputs. Ice-phobic tape was found to be at best ineffective in inducing rotor blade self-shedding. No vehicle damage was sustained as the result of this periodic shedding. This paper summarizes the Cheyenne ice protection design philosophy, briefly discusses the extent of such protection and describes the performance of the vehicle in the NRC icing rig. (Author)

A71-15439 # Environmental development of the U.S. Army OH-58A light observation helicopter. Myron M. Kawa (Bell Helicopter Co., Fort Worth, Tex.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc.,

1970. 16 p.

This paper will describe the steps taken during the development cycle of the OH-58A to generate a helicopter that would easily endure the severe environmental conditions that are a prime requirement of U.S. Army helicopters operating in close support of ground troops. Major areas to be covered include the development of a particle separator to protect the engine against dust, sand, ice, and debris, erosion, corrosion protection for the rotors and improvements in seals for protection of bearings against sand and water ingestion. The intensive environmental testing, both laboratory and flight that was accomplished to refine the aircraft systems will be covered in detail. As a result of this comprehensive testing the U.S. Army OH-58A helicopter enjoys the highest reliability and lowest maintainability requirement of any helicopter in the Army inventory. (Author)

A71-15440 # A report on the heliport environment. Arthur L. Fornoff (Bell Helicopter Co., Fort Worth, Tex.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 4 p.

Discussion of the state of helicopters, heliports, and helistops. It is shown that, although the number of heliports in the U.S., Canada, and Puerto Rico rose to 1892 in 1968, the great majority of these facilities are for private or government use, and are not available to the public. It is considered that there is a need for additional heliports to ensure that every city will be ready for helicopter door-to-door travel. F.R.L.

A71-15441 # Federal design criteria for VTOL ports and STOL ports. George L. Buley (FAA, Washington, D.C.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 4 p.

Concise outline of the Federal Government's role in the planning, design, and construction of VTOL and STOL ports. Seven major topics are treated: (1) responsibility for airport development, (2) Airport Development Aid Program (ADAP), (3) the National Airport Systems Plan (NASP), (4) the development of Federal design criteria, (5) VTOL port criteria, (6) STOL port criteria, and (7) environmental considerations. F.R.L.

A71-15442 # Public-use heliports, STOLports, V-ports - A cure for congestion. Jean Ross Howard (Aerospace Industries Association of America, Inc., Washington, D.C.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 4 p.

Discussion of the need for a major government-industry program to use the available space above clogged street and highway ground traffic, and below the increasingly congested upper air traffic. The suggested program would provide public-use ground level and rooftop landing facilities close to city and suburban traffic-generating areas. Attention is given to the CAB Northeast Corridor Investigation, and to the 1970 Airport and Airways Development Act. F.R.L.

A71-15443 * # Effect of the city center environment on VTOL terminal operations. Walter M. Hollister (MIT, Cambridge, Mass.), Dorian A. De Maio, Thorgeir Palsson, and Joseph P. Tymczyszyn. In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 11 p. 11 refs. Contract No. NAS 12-2081.

This paper is a summary report of several studies aimed at the determination of optimum flight paths for V/STOL aircraft operating in a short-haul flight transportation system near city centers. The approach to the problem has been to minimize costs associated with fuel and time, subject to constraints established by considerations of safety, traffic and noise. An optimization was first carried out subject to general constraints on approach angle, velocity and rate of descent. For even the most costly type of VTOL aircraft there is a relatively small increase in fuel cost for steep approaches and departures as opposed to conventional glide slopes and climb angles when realistic constraints on safety are applied to both. Specific constraints were determined by an in-depth study of proposed

terminal sites near metropolitan Boston. Practical constraints due to noise and traffic required high angle departures (20 deg) and curvilinear approaches with steep (15 deg) glide slopes. Efficient utilization of the terminal airspace and VTOL landing pads will dictate a requirement for 4-dimensional area navigation. (Author)

A71-15444 # Experiments on pilot visibility from a V/STOL in overwater hover. George Kurylowich and Alfred Ritter (Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 12 p. 11 refs. Contracts No. N 00014-66-C-0320; No. N 00014-68-C-0241.

A test program which investigated in small scale the phenomenon of spray generation and the resulting impairment to pilot vision when an inline VTOL configuration, such as the LTV XC-142A, is in low-altitude overwater hover is described. Also given are the improvements to pilot vision when defectors are used to divert the spray from principal regions of interest to a pilot. A device in close proximity to the fuselage is, at best, only locally effective. The major conclusion is that a deflector positioned at the water surface cavity produced by the slipstreams of the propellers can be very effective in reducing spray. The use of such a deflector, however, may present potential problems affecting hover performance and spray ingestion through the propeller plane. (Author)

A71-15445 # V/STOL flight evaluation of visual aids in relation to minimum landing area operations. John A. Johnston (U.S. Army, Edwards AFB, Calif.). In: American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Designs, Arlington, Tex., November 16-18, 1970, Proceedings. New York, American Helicopter Society, Inc., 1970. 6 p.

Description of a flight evaluation of visual landing aids positioned around small landing areas. Test objectives were to evaluate aircraft landings using only visual aids, and to assess the impact of landing area shape and size on the landing task. The evaluation was carried out in three phases. In the first phase, the aircraft departed vertically from a large concrete area and horizontally transitioned to a pattern of visual aids. In the second phase, the aircraft took off, translated to a pattern positioned on a large concrete area, and landed vertically, using visual aids for orientation. In the third phase, the aircraft completed a landing on a small pad. F.R.L.

A71-15447 # Seventy survivability. Eugene B. Conrad (U.S. Army, Board for Aviation Accident Research, Fort Rucker, Ala.). *American Helicopter Society, American Institute of Aeronautics and Astronautics, and University of Texas, Joint Symposium on Environmental Effects on VTOL Design, Arlington, Tex., Nov. 16-18, 1970, Paper. 8 p.*

As a result of the Vietnam conflict and its attendant rapid expansion of Army Aviation, we have learned many valuable lessons. A review of Army helicopter experience in Vietnam reveals that improved equipment design would not only increase combat survivability, but would go a long way in reducing operational accidents, thereby having a two-fold impact on conserving aviation assets. In this paper, I have discussed certain requirements for improved aircraft design and outlined some rotary wing aircraft weaknesses which must be corrected if the survivability of the helicopter is to be improved. (Author)

A71-15449 # Assembly of aircraft gas turbine engines (Sborka aviatsionnykh gazoturbinnnykh dvigatelei). V. I. Sokolov, L.

K. Nikolenko, D. E. Smirnov, and T. A. Dushina. Moscow, Izdatel'stvo Mashinostroenie, 1969. 345 p. 10 refs. In Russian.

Procedures and recommendations are given for the assembly of gas turbine engine elements, including rules for the organization of assembly operations. Methods of ensuring specified accuracy are discussed, and attention is given to automatic assembly systems, alignment instruments, and conveyer transports. Different types of joints are characterized in terms of their particular problems and assembly solutions. Geared transmissions, sliding and rolling bearings, flanged connections, tensed joints, and various types of couplings are analyzed for factors affecting their quality and reliability. The theory of rotor balancing is treated extensively, and descriptions are given of the design and application of balancing machines. Theoretical fundamentals of organizing assembly operations are delineated and illustrated by examples of function sequences for representative components. Reproducibility of operations is treated in terms of automation and mechanization problems. Environmental aspects of work safety, fire control, work area allocation, and power distribution are also considered. T.M.

A71-15474 The influence of strong pressure gradients on film cooling effectiveness. B. R. Pai and J. H. Whitelaw (Imperial College of Science and Technology, London, England). In: Heat transfer 1970; Assembly for International Heat Transfer Conferences, International Heat Transfer Conference, 4th, Versailles, France, August 31-September 5, 1970, Preprints. Volume 2 - Forced convection (Sessions FC 1-FC 5). Edited by Ulrich Grigull and Erich Hahne. Amsterdam, Elsevier Publishing Co., 1970, p. FC 1.11.1-FC 1.11.10. 13 refs.

Investigation of the influence of strong, favorable, and adverse pressure gradients on the impervious-wall film cooling effectiveness for nondimensional distances from 0 to 212, ratios of slot to mainstream velocity from 0.55 to 2.21, and ratios of slot to mainstream density from 0.069 to 4.17. The results demonstrate the influence of slot Reynolds number in constant density flow and the influence of pressure gradients in constant- and nonconstant-density flows. T.M.

A71-15483 Some heat transfer features in the air flows of intensified turbulence. E. P. Dyban and E. Ia. Epik (Institute of Engineering Thermophysics, Kiev, Ukrainian SSR). In: Heat transfer 1970; Assembly for International Heat Transfer Conferences, International Heat Transfer Conference, 4th, Versailles, France, August 31-September 5, 1970, Preprints. Volume 2 - Forced convection (Sessions FC 1-FC 5). Edited by Ulrich Grigull and Erich Hahne. Amsterdam, Elsevier Publishing Co., 1970, p. FC 5.7.1-FC 5.7.10. 16 refs.

The authors present experimental data on effect of flow turbulence level on heat transfer and boundary layer development at flowing around flat plate, aerodynamical profile and cylinder. The method of account for external flow turbulence effect on heat transfer is proposed. (Author)

A71-15486 Experimental study of heat transfer on lifting body surface in supersonic stream. V. Ia. Borovoi, R. Z. Davlet-Kildeev, and M. V. Ryzhkova. In: Heat transfer 1970; Assembly for International Heat Transfer Conferences, International Heat Transfer Conference, 4th, Versailles, France, August 31-September 5, 1970, Preprints. Volume 3 - Forced convection (Sessions FC 6-FC 9); Radiation (Sessions R 1, R 2). Edited by Ulrich Grigull and Erich Hahne. Amsterdam, Elsevier Publishing Co., 1970, p. FC 6.2.1-FC 6.2.10.

Study of the effect of Reynolds number, incidence, and body shape of lifting bodies at Mach 5 and 6 on the maximum heat transfer coefficient on the leeward surface. Pointed and blunted cones are studied, not only because of their simple geometry but also because the shape of some hypersonic vehicles described in the literature approaches a half-cone. In investigating the heat transfer,

two positions of a half-cone are considered: the top flat surface, and the bottom flat surface. The method of temperature-sensitive coatings is used for this purpose; temperature sensitive paints are used which change their colors at a specific temperature which does not depend on the pressure. This method makes it possible to determine local characteristics of heat transfer. Along with quantitative results, the general pattern of the flowfield and heat transfer is thus obtained. O.H.

A71-15487 Laminar heat transfer calculation on conical bodies in supersonic flow. Kalle Kaups and Gerlina L. Keltner (Douglas Aircraft Co., Long Beach, Calif.). In: Heat transfer 1970; Assembly for International Heat Transfer Conferences, International Heat Transfer Conference, 4th, Versailles, France, August 31-September 5, 1970, Preprints. Volume 3 - Forced convection (Sessions FC 6-FC 9); Radiation (Sessions R 1, R 2).

Edited by Ulrich Grigull and Erich Hahne. Amsterdam, Elsevier Publishing Co., 1970, p. FC 6.3.1-FC 6.3.11. 14 refs.

The laminar boundary-layer development on conical bodies of arbitrary cross section is calculated with a method of solution based on quasi-linearization and an implicit finite-difference method. Boundary conditions include arbitrary circumferential distribution of wall temperature, heat transfer, and blowing or suction. Fluid-property options are perfect gas or real gas in equilibrium. Sample calculations that make use of exact inviscid solutions, are given for circular cones. The main results are circumferential shear stress and heat-transfer distributions showing the effects of wall temperature, blowing and suction, angle of attack and cone half-angle. (Author)

A71-15488 Diffusive effects on recovery temperature in supersonic flow of rarefied gas mixture. S. S. Kutateladze, A. A. Bochkarev, V. G. Prikhodko, and A. K. Rebrov (Akademii Nauk SSSR, Institut Teplofiziki, Novosibirsk, USSR). In: Heat transfer 1970; Assembly for International Heat Transfer Conferences, International Heat Transfer Conference, 4th, Versailles, France, August 31-September 5, 1970, Preprints. Volume 3 - Forced convection (Sessions FC 6-FC 9); Radiation (Sessions R 1, R 2).

Edited by Ulrich Grigull and Erich Hahne. Amsterdam, Elsevier Publishing Co., 1970, p. FC 6.4.1-FC 6.4.8.

Study of the structure of a rarefied hypersonic flow of a binary gas mixture near a blunt body, as well as the dependence of the temperature recovery factor on the parameters of the jet and on the position of the body in the jet axis. The electron beam technique was used to measure the argon concentration in a supersonic jet and in the vicinity of a body streamlined by a free jet of an argon-helium gas mixture. Experiments were carried out to measure the recovery temperature in the stagnation point of a streamlined body in nitrogen-hydrogen gas mixtures. Dependences were obtained of the recovery temperature upon the position of the body in the jet axis, upon Re calculated from parameters behind the detached shock wave, and upon the original gas mixture concentration. O.H.

A71-15489 Heat transfer in the started supersonic axisymmetric parallel diffuser. T. Mukerjee and B. W. Martin (Imperial College of Science and Technology, London, England). In: Heat transfer 1970; Assembly for International Heat Transfer Conferences, International Heat Transfer Conference, 4th, Versailles, France, August 31-September 5, 1970, Preprints. Volume 3 - Forced convection (Sessions FC 6-FC 9); Radiation (Sessions R 1, R 2).

Edited by Ulrich Grigull and Erich Hahne. Amsterdam, Elsevier Publishing Co., 1970, p. FC 6.5.1-FC 6.5.12. 33 refs. Research supported by the Ministry of Technology.

A theoretical and experimental investigation is reported of heat transfer in the started supersonic axisymmetric parallel diffuser. The measurements indicate broad correspondence between wall static pressure and heat-transfer distributions along the duct, particularly in the separated and reattachment regions near the diffuser entry.

Downstream of reattachment the flow develops as in the entry region of a circular-section tube in reverse. Predicted distributions of wall heat-transfer coefficient based on a pseudo-shock model accord well with measurements. (Author)

A71-15490 Heat transfer to the stagnation point of the blunt body in hypersonic flow. L. M. Biberman, S. Ia. Bronin, and A. N. Lagar'kov (Akademii Nauk SSSR, Nauchno-Issledovatel'skii Institut Vysokikh Temperatur, Moscow, USSR). In: Heat transfer 1970; Assembly for International Heat Transfer Conferences, International Heat Transfer Conference, 4th, Versailles, France, August 31-September 5, 1970, Preprints. Volume 3 - Forced convection (Sessions FC 6-FC 9); Radiation (Sessions R 1, R 2).

Edited by Ulrich Grigull and Erich Hahne. Amsterdam, Elsevier Publishing Co., 1970, p. FC 6.6.1-FC 6.6.12. 17 refs.

Study of heat transfer to the stagnation point in a blunt body entering the earth's atmosphere in the velocity range 12-20 km/sec. The equations of gasdynamics which describe the flowfield in the vicinity of the critical streamline include the effects of viscosity, heat conductivity, and relative energy transfer. The real spectrum of heated air is considered. Values of conductive and radiative heat fluxes toward the body are obtained in a wide range of flow parameters. The radiative effects result in a set of new features of heat transfer in the stagnation point. O.H.

A71-15493 Heat transfer to a transverse circular cylinder at low Reynolds numbers including rarefaction effects. K. M. Krall (LTV Research Center, Dallas, Tex.) and E. R. G. Eckert (Minnesota, University, Minneapolis, Minn.). In: Heat transfer 1970; Assembly for International Heat Transfer Conferences, International Heat Transfer Conference, 4th, Versailles, France, August 31-September 5, 1970, Preprints. Volume 3 - Forced convection (Sessions FC 6-FC 9); Radiation (Sessions R 1, R 2).

Edited by Ulrich Grigull and Erich Hahne. Amsterdam, Elsevier Publishing Co., 1970, p. FC 7.5.1-FC 7.5.11. 15 refs.

An analytical investigation of the local heat transfer about a circular cylinder is presented. The range of Reynolds numbers is 20 to 200. The steady, incompressible Navier-Stokes and energy equations in cylindrical coordinates are solved numerically. An iterative finite difference approach utilizing the concept of donor cell differencing for the convective terms was adapted. Heat transfer results for both uniform wall temperature and uniform heat flux conditions are presented for Reynolds numbers of 20, 50, 100, and 200, the latter displaying a 20-30 per cent increase on the average. The influence of rarefaction is investigated for a Mach number of 0.25, employing the first order slip conditions on both velocity and temperature. Slip decreases the heat transfer by up to 6 per cent.

(Author)

A71-15553 # Asymptotic behavior with respect to kappa approaches 1 in the problem of hypersonic flow past blunt bodies (Asimptotika po kappa approaches 1 v zadache giperzvukovogo obtekanii zatuplennykh tel). R. G. Barantsev, V. P. Petrov, and I. M. Tsitelov. *Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia*, vol. 25, July 1970, p. 83-91. 11 refs. In Russian.

Solution of the direct problem of steady two-dimensional (plane or axisymmetric) ideal gas flow past a blunt body at an incident Mach number of infinity. An attempt is made to obtain rigorous asymptotic expansions of the gasdynamic variables as kappa approaches infinity in the entire domain of definition of these variables. The main terms of the asymptotic forms of all the unknown functions are presented for the case of a body with a finite radius of curvature of the nose. A.B.K.

A71-15615 # Some problems concerning the effect of injection on a turbulent boundary layer (Nekotorye voprosy vozdeistviia vduvaniia na turbulentnyi pogranichnyi sloi). V. P.

Mugalev. In: Turbulent flows; All-Union Symposium on Problems of Turbulent Flows, Including Geophysical Applications, Kiev, Ukrainian SSR, June 16-21, 1967, Transactions (Turbulentnyi techeniia; Vsesoiuznyi Simpozium po Problemam Turbulentnykh Tehenii, Vkluchaia Geofizicheskie Prilozheniia, Kiev, Ukrainian SSR, June 16-21, 1967, Trudy). Edited by Iu. G. Gurevich. Moscow, Izdatel'stvo Nauka, 1970, p. 87-92. 7 refs. In Russian.

Review of wind tunnel experiments in which the thermodynamic behavior of boundary layers was studied in airflows during air, helium, or CO₂ injection into the main flow through porous nozzles. Special attention is given to heat transfer intensification during injection, showing that the roughness of the porous surfaces used and the Joule-Thomson effect have no bearing on the intensification. V.Z.

A71-15622 # Experimental study of the mixing of isothermal and nonisothermal turbulent slipstreams in nozzles (Eksperimental'noe issledovanie smesheniia izotermicheskikh i neizotermicheskikh turbulentnykh sputnykh strui v soplakh). V. L. Zimont. In: Turbulent flows; All-Union Symposium on Problems of Turbulent Flows, Including Geophysical Applications, Kiev, Ukrainian SSR, June 16-21, 1967, Transactions (Turbulentnye techeniia; Vsesoiuznyi Simpozium po Problemam Turbulentnykh Tehenii, Vkluchaia Geofizicheskie Prilozheniia, Kiev, Ukrainian SSR, June 16-21, 1967, Trudy). Edited by Iu. G. Gurevich. Moscow, Izdatel'stvo Nauka, 1970, p. 138-144. 5 refs. In Russian.

Description of experiments in which a dispersion criterion referred to the radius of a cylindrical combustion chamber was used to describe the mixing process occurring when a hot stream consisting of air-diluted gasoline combustion products was partially mixed with a slipstream of cold air and then was admitted into a tapering nozzle. Expressions are given for the criterion and for a characteristic of the mixing process. Conditions for the intensification of the mixing process when the flow in the nozzle is nonisothermal and the initial turbulence level is low are also studied. Various diagrams characterizing the mixing process are plotted. V.Z.

A71-15626 # Application of turbulent jet theory to an analysis of separation flow between two bodies (Primenenie teorii turbulentnykh strui k analizu otryvnogo techeniia mezhdv dvumia telami). A. Ia. Cherkez, Iu. L. Karpov, V. N. Kudriavtsev, N. F. Ovchinnikova, Iu. P. Semenkevich, and V. A. Shilov. In: Turbulent flows; All-Union Symposium on Problems of Turbulent Flows, Including Geophysical Applications, Kiev, Ukrainian SSR, June 16-21, 1967, Transactions (Turbulentnye techeniia; Vsesoiuznyi Simpozium po Problemam Turbulentnykh Tehenii, Vkluchaia Geofizicheskie Prilozheniia, Kiev, Ukrainian SSR, June 16-21, 1967, Trudy). Edited by Iu. G. Gurevich. Moscow, Izdatel'stvo Nauka, 1970, p. 163-168. In Russian.

Consideration of the problem of supersonic flow past a notch in the lateral surface of a body or between two closely lying coaxial bodies. On the basis of turbulent jet theory a method of determining the flow parameters within the separation zone in the notch or between the bodies is developed. It is shown that the flow parameters depend on the relative distance between the bodies, the ratio between the diameters, and the relative velocity of the bodies. The results of a calculation are compared with experimental results. The results of aeroballistic experiments with composite models which come apart in free flight are cited. A.B.K.

A71-15646 The equations of air collisions. Victor Attwooll (Royal Aircraft Establishment, Farnborough, Hants., England). *New Scientist*, vol. 48, Dec. 10, 1970, p. 444-446.

Discussion of approaches to meet the air-traffic control require-

ments of the future giving attention to an analysis using collision risk equations. The chances of collision between two aircraft flying in a roughly parallel direction, but deviating from their intended paths because of various kinds of error are investigated making use of equations which give the expected number of collisions for each mode of collision. The application of this analysis to the North Atlantic traffic system and to Britain's airspace is discussed. It is pointed out that an air traffic system in which all aircraft follow the most direct course is not feasible at present because of the complexity of the work which the computer would have to perform. The merits of an airborne collision avoidance system developed in the U.S. are critically examined. G.R.

A71-15669 # Stress analysis of the McDonnell Douglas DC-10 nose landing gear unit. D. S. Gullick and B. D. Birch (Dowty Rotol, Ltd., Gloucester, Glos., England). *Aircraft Engineering*, vol. 42, Dec. 1970, p. 6-9, 27.

Account of the use of a photoelastic coating technique to determine the stress distribution and maximum stress areas over the external surface of the nose undercarriage assembly of the McDonnell Douglas DC-10. The results are compared with the results of measurements by strain gauges, using a data logger system for recording. Principal direct and shear strains and stresses, equivalent uniaxial stresses, and angles of the principal X axis are calculated in the process. Causes of discrepancies between the results of the two measurement series are discussed. V.Z.

A71-15670 # High temperature turbine design considerations. S. N. Suci (General Electric Co., Aircraft Engine Group, West Lynn, Mass.). *Aircraft Engineering*, vol. 42, Dec. 1970, p. 10, 12-17. 14 refs.

Discussion of major technological developments which resulted in the advent of aircraft gas turbine engine designs with elevated gas inlet temperatures. The topics include manufacturing processes, material properties, cooling techniques, mixing and aerodynamic losses, mechanical designs, mechanical and thermal life, metallurgical stability, and coating interactions. A manifold evolutionary process rather than individual dramatic breakthroughs are shown to facilitate the progressive evolution of these turbine engine designs. V.Z.

A71-15674 # Design and construction of Sprite. L. Jenkinson and P. Sharman (Loughborough University of Technology, Loughborough, Leics., England). *Aircraft Engineering*, vol. 42, Dec. 1970, p. 24-27.

Account of design considerations and construction procedures for a light Sprite aircraft to be built at home by nonprofessionals. The initial design specifications of the aircraft are given as a wing span of 24 ft, an overall length of 20 ft, a constant wing chord of 4 ft, a gross wing area of 96 sq ft, and a 48 in. wide cockpit with a one-piece sliding canopy. The engine installation and cowling lines of the aircraft are designed to accommodate various types of engine without major changes in the aircraft structure. At least 40 aircraft are currently in construction, and the first individually built one is expected to be airborne next fall. V.Z.

A71-15819 Tests of silencers for jet aircraft (Essais des silencieux de jet pour avions à réaction). Georges Bruner (Centre de Documentation de l'Armement, Paris, France). *L'Aéronautique et l'Astronautique*, no. 24, 1970, p. 47-55. In French.

Description of the techniques and facilities used in the development tests of a new Bréguet jet noise suppressor. The various model tests described include: those performed at the hydrodynamic ONERA wind tunnel for verifying the effectiveness of the functional principle involved; the perceived noise measurements in the sound-proof chamber of the Propulsor Test Center; determination of the

high-speed, takeoff, and on-stand thrust losses on the Bertin test bench in the S2ch and S2ma ONERA wind tunnels; and measurements of noise from the jet engine while in high speed motion on the Bertin No. 2 air-cushion (aerotrain) vehicle. M.V.E.

A71-15873 The reliability of the VC 10 ILS equipment. H. Sargeant (Royal Aircraft Establishment, Farnborough, Hants., England). *Microelectronics and Reliability*, vol. 9, Nov. 1970, p. 469-490.

Field reliability study of the instrument landing system (ILS) electronics equipment fitted in the B.O.A.C. VC 10 aircraft. The equipment investigated included the Type 6401 Navigation/Communication Receiver, the Type 6402 Navigation Unit, the Type 6403 Marker Receiver, the Type 6404 Glide Slope Receiver, and the Type 6414 Controller. G.R.

A71-15901 You have been warned. W. Lawrence. *Flight International*, vol. 98, Dec. 17, 1970, p. 943-946.

Discussion of sophisticated methods of detecting faults in aircraft systems. For efficient operation, a fault identification panel which indicates where the fault has occurred is required, as well as a crew alert system and the detailed warning lights and other indications on the panel. Attention is given to master warning systems, which are sometimes used to provide warning of events other than failures of aircraft equipment. There is a trend to change the sound of traditional audio warnings and remedy a lack of standardization of audio warnings between different aircraft types. F.R.L.

STAR ENTRIES

N71-12201 Kansas Univ., Lawrence.
**WIND TUNNEL INVESTIGATIONS OF VORTEX
 BREAKDOWN ON SLENDER SHARP-EDGED WINGS**
 William Henry Wentz, Jr. (Ph.D. Thesis) 1969 121 p
 Avail: Univ. Microfilms: HC \$6.00/Microfilm \$3.00 Order No.
 69-21593

Systematic wind tunnel investigations of vortex breakdown on sharp-edged delta and modified delta wings with sweep angles from 45 deg to 85 deg at Reynolds numbers of about 1 million, utilizing a schlieren system for flow visualization are discussed. Vortex breakdown positions are presented as a function of angle of attack and sweep. Results agree well with the limited amount of previously published data. For the very slender wings (75 deg to 85 deg sweep), initial breakdown was nearly independent of sweep, a result not anticipated by extrapolation of previous data.

Dissert. Abstr.

N71-12202# Stanford Univ., Calif. Thermosciences Div.
**THE EFFECTS OF ROTATION ON BOUNDARY LAYERS IN
 TURBOMACHINE ROTORS**
 J. P. Johnston May 1970 64 p refs
 (Grants NSF GK-2533; NSF GK-671)
 (PB-192316; MD-24) Avail: NTIS CSCL 10A

The boundary layers in turbomachine rotors are subject to Coriolis forces which can (1) contribute directly to the development of secondary flows, and (2) indirectly influence the behavior of boundary layers by augmentation and/or suppression of turbulence production in the boundary layers on blades. Both these rotation-induced phenomena are particularly important in the development of understanding of flow and loss mechanisms in centrifugal and mixed flow machines.

Author (USGRDR)

N71-12203# West Virginia Univ., Morgantown. Dept. of
 Aerospace Engineering.
**AN EXPERIMENTAL INVESTIGATION OF ROTOR FORCES
 AND FLOW FIELD IN THE VICINITY OF A STEP GROUND
 PLANE**
 Ojars Skujins Jul. 1970 102 p refs
 (Contract N00014-68-A-0512; Proj. Themis)
 (AD-711955; TR-24) Avail: NTIS CSCL 1/1

The rotor force parameters considered were thrust, torque, pitching moment, and normal force, for the simulated flight conditions of hover, takeoff, and landing. The flow parameters investigated included tip vortex trajectories and streamline patterns. Additional studies were made to consider the effects of rotor blade mismatching upon thrust and power requirements of a rotor system.

Author (TAB)

N71-12204# Aerospace Research Labs., Wright-Patterson AFB,
 Ohio.
**VISCOUS INTERACTIONS AND FLIGHT AT HIGH MACH
 NUMBERS** Final Report
 Robert H. Korkegi Jul. 1970 64 p refs
 (AD-712075; ARL-70-0124) Avail: NTIS CSCL 20/4

Viscous interactions which arise in regions of high compression on high Mach number vehicles, can result in severely high local heating and flow degradation. Regions where such strong interactions may occur on a cruise vehicle are discussed. In relation to these regions, a brief review is given of advances in the understanding of two-dimensional shock wave-boundary layer interaction and separation in compression corners, and such three-dimensional interaction problems as a blunt fin on a surface, flow in an axial corner, and shock impingement. It is concluded that much progress has been made in analytical prediction of two-dimensional laminar interactions and a promising approach advanced for the turbulent case; knowledge of departures from two-dimensional flow and three-dimensional interactions is still largely empirical and dominantly qualitative, and even the inviscid flow field is not well known for many configurations of practical importance.

Author (TAB)

N71-12205# Naval Ordnance Lab., White Oak, Md.
**AN INVESTIGATION OF THE EFFECT OF FLEXIBLE
 TRAILING WIRE ON A HYPERVELOCITY CONE**
 Norman W. Sheetz, Jr. and Magonis V. Krums 11 Mar. 1970
 61 p
 (AD-712509; NOLTR-70-49) Avail: NTIS CSCL 20/4

A program to investigate the effect of a flexible trailing wire on the aerodynamic characteristics of a cone at very high Mach numbers is described. The experimental program was conducted in a 1000-foot hyperballistics range. The development of the technique for launching a conical configuration which has a small-diameter flexible wire attached to its base is described in detail. The effect of this appendage on the drag coefficient and the stability of the cone is presented. Also, the radar cross section of a cone with and without the trailing wire is compared.

Author (TAB)

N71-12206# Naval Ship Research and Development Center,
 Washington, D.C.
**AN INVESTIGATION OF THE EFFECT OF REYNOLDS
 NUMBER ON VELOCITY SURVEYS CONDUCTED IN THE
 SUBSONIC WIND TUNNEL**
 Albert L. Boyle Sep. 1970 22 p ref
 (AD-712527; NSRDC-3408) Avail: NTIS CSCL 20/4

Results are presented of an investigation of the effect of Reynolds number on velocity surveys conducted in a subsonic wind tunnel. A series of velocity surveys was conducted over a wide range of wind velocities. The surveys were made behind two configurations--an axisymmetrical body with appendages and a three-cycle wake screen. The shape of the velocity distribution curves was related to changes in wind velocity; the mean values of the distributions were also related to velocity.

Author (TAB)

N71-12207# New York Univ., N.Y. Dept. of Aeronautics and
 Astronautics.
**THE STABILITY OF SMOOTH TWO-DIMENSIONAL
 TRANSONIC FLOWS** Final Report
 Morris P. Isom and Kwang Shu Wu Jun. 1970 29 p refs
 (Grant AF-AFOSR-1578-68)
 (AD-712702; NYU-AA-70-14; AFOSR-70-1787TR) Avail: NTIS
 CSCL 20/4

The stability of smooth (shock-free) two-dimensional transonic flows to acoustic disturbances is discussed. The problem is considered in the context of transonic flow over airfoil sections, with weak waves moving upstream into the region of embedded supersonic flow. In particular, Spees work on stability criteria for such flows is reviewed, and the problem is reformulated within the framework of geometrical acoustics. It is shown that the assumptions appropriate for a linearized theory appear to fail when acoustic waves become tangent to characteristics of the undisturbed flow field. The assumptions of linear theory are implicit in Spees work. The results presented here indicate that stability theory must be based on a more careful and detailed analysis of wave propagation through the supersonic region.

Author (TAB)

N71-12208* National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

OVERALL PERFORMANCE OF 6-INCH RADIAL-BLADED CENTRIFUGAL COMPRESSOR WITH VARIOUS DIFFUSER VANE SETTING ANGLES

Calvin L. Ball, Carl Weigel, Jr., and Edward R. Tysl Washington Nov. 1970 20 p refs

(NASA-TM-X-2107; E-5681) Avail: NTIS CSCL 20D

Overall compressor performance is presented as a function of equivalent weight flow for five different diffuser vane setting angles. For design speed, the weight flow corresponding to the peak efficiency was varied from 100 percent of design flow to 65 percent by operating the compressor with the five different diffuser vane angles. Over the range of diffuser vane setting angles tested, the peak efficiency of the compressor remained essentially constant at 78 percent.

Author

N71-12209* National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

OVERALL PERFORMANCE IN ARGON OF 4.25-INCH SWEPTBACK-BLADED CENTRIFUGAL COMPRESSOR

Carl Weigel, Jr., Edward R. Tysl, and Calvin L. Ball Washington Nov. 1970 19 p refs

(NASA-TM-X-2129; E-5582) Avail: NTIS CSCL 20D

Overall compressor performance is presented as a function of equivalent weight flow. At the design equivalent weight flow of 0.581 lb/sec (0.263 kg/sec) and the design equivalent tip speed of 949 ft/sec (289 m/sec), the compressor produced an overall total-pressure ratio of 1.92 and an adiabatic efficiency of 0.795. The peak efficiency at design speed was 0.819 and occurred at an equivalent weight flow of 0.508 lb/sec (0.230 kg/sec).

Author

N71-12210* Lockheed Missiles and Space Co., Sunnyvale, Calif. Aero-Thermodynamics.

ANALYSIS OF THE EXPERIMENTALLY DETERMINED AERODYNAMIC NOISE ENVIRONMENT FOR THREE NOSE-CYLINDER CONFIGURATIONS

J. Peter Reding and Rolf A. Guenther Oct. 1969 53 p refs

(Contracts NAS8-21459; F04701-68-C-0061)

(NASA-CR-102933; N-3C-69-2) Avail: NTIS CSCL 20D

Aerodynamic noise measurements were obtained on three nose-cylinder configurations, a 15 deg cone-cylinder, a biconic nose-cylinder, and a biconic nose-corrugated cylinder. The measurements were intended to assess the effects of the biconic nose and corrugated skin on the aerodynamic noise environment. However, an analysis of the data revealed that the model skin may have been vibrating. The resultant accelerations experienced by the microphones and perturbations of the flow preclude valid noise measurements except directly under the terminal normal shock where the very high aerodynamic noise dominates the microphone response. The biconic nose with smooth afterbody produced lesser shock-induced sound pressure levels (SPL's) than the aerodynamically cleaner single cone-cylinder configuration. This was due primarily to the reduced flow turning at the nose-cylinder shoulder aft of the preseparation and reattachment at the upstream cusp. The biconic corrugated configuration produced the most severe noise environment due to local effects at the corrugation leading edges, including the vorticity shed along the corrugation edges.

Author

N71-12211* North American Rockwell Corp., Los Angeles, Calif. **DYNAMIC DISTORTION AT THE EXIT OF A SUBSONIC DIFFUSER OF A MIXED COMPRESSION INLET**

Arnold W. Martin, Leonard C. Kostin, and Sidney D. Millstone Washington NASA Dec. 1970 349 p refs

(Contract NAS2-4667)

(NASA-CR-1644) Avail: NTIS CSCL 20D

Dynamic distortion characteristics at the engine face station of a 20 in. diameter axisymmetric inlet were investigated at $M = 2.6$ and 3.0. Inlet operation modes included: (1) stationary geometry and tunnel conditions, (2) sinusoidal exit area disturbances, (3) simulated engine transients, (4) sinusoidal external flow disturbances, and (5) simulated clear air turbulence. Inlet-induced turbulence is composed of random and nonrandom pressure oscillations. The basic turbulence generating mechanism appears to be boundary layer/shock interaction. Regions of maximum turbulence correspond with regions of maximum pressure recovery. Instantaneous (msec) spatial distortions appreciably exceed steady state distortions during highly supersonic inlet operation.

Author

N71-12212 Northwestern Univ., Evanston, Ill.

EXPERIMENTAL INVESTIGATION OF MAGNETOAERODYNAMIC FLOW AROUND BLUNT BODIES

Stanley Charles Kranc (Ph.D. Thesis) 1969 166 p

Avail: Univ. Microfilms: HC \$7.80/Microfilm \$3.00 Order No. 70-94

The drag forces on a body with a self-contained electro-magnet are measured when the body is placed in a low density argon plasma stream. Tests are conducted in a steady flow of plasma produced in a direct current arc and expanded to supersonic speeds. Measurements are restricted to one flow condition where the influence of viscosity and the Hall effect are both important. The flow field around the body is investigated spectroscopically, and the predicted increase in shock stand-off distance is observed photographically. An unexpected visible color change which occurs when the magnetic field is applied is also investigated. Spectroscopic measurements show that the electrons in the plasma are out of thermal equilibrium in the plasma and the flow is essentially non reacting. The influence of these facts on other experimental measurements is considered.

Dissert. Abstr.

N71-12213* National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

THEORETICAL ANALYSIS AND MEASUREMENT OF SINGLE-PHASE PRESSURE LOSSES AND HEAT TRANSFER FOR HELICAL FLOW IN A TUBE

Martin U. Gutstein, George L. Converse (GE., Cincinnati), and Jerry R. Peterson (GE., Cincinnati) Washington Nov. 1970 58 p refs

(NASA-TN-D-609; E-5743) Avail: NTIS CSCL 20D

An analysis of flow inside a tube containing a helical-vane insert was conducted based on solid-body rotation. Equations were derived for the momentum and frictional pressure losses for fully developed flow in these inserts. Modified plain-tube expressions for friction factor and Stanton-Prandtl modulus, obtained from the analysis, were used to predict the performance of tubes with helical-vane inserts. Experimentally determined friction factors and Stanton-Prandtl moduli, obtained with four different inserts over a Reynolds number range of 30,000 to 300,000, were found to deviate from the predictions by about + or - 20 and + or - 15 percent, respectively, suggesting the analysis to be largely correct. A similar approach for other swirl-generating inserts yielded reasonable agreement of experimental data with predictions.

Author

N71-12214* Royal Aircraft Establishment, Farnborough (England). **FLIGHT ASSESSMENT OF A DOUGLAS TRAILING-CONE STATIC-PRESSURE PROBE AT SUBSONIC SPEEDS**

C. S. Barnes Jul. 1969 26 p refs

(RAD-TR-69139) Avail: NTIS

Pressure error evaluation tests were made, using the tower fly-by technique at speeds up to 350 kt ($M = 0.53$), with promising results. The cone, which was trailed from the fuselage tail cone of a Meteor aircraft, had a pressure error at sea level equivalent to less than + or - 10 feet error in altitude for trail

lengths greater than 50 feet and for most aircraft configurations. This error was significantly increased by aircraft flap deflection which caused cone unsteadiness, probably due to rotation of the cone within the flap vortex. It is believed that this behavior would not occur if the cone were trailed from the fin tip of the test aircraft. The results suggest that there might be slight interference from the jet wakes of the wing mounted engines of the Meteor, but this could not be confirmed. Author

N71-12215* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EXPERIMENTAL STUDY OF THE SHOCK WAVE DUE TO A BLUNT LEADING EDGE IN THE HYPERSONIC MERGED-FLOW REGIME

Roger M. Winebarger Washington Dec. 1970 19 p refs (NASA-TN-D-6017; L-7019) Avail: NTIS CSCL 01A

An experimental investigation of low-density flow over two-dimensional blunt bodies was conducted in the Langley 1-foot (0.305-meter) hypersonic arc tunnel. Pitot-pressure surveys were obtained over a range of tunnel test conditions with Mach number varying from 11.8 to 13.7, total enthalpy varying from 2.41 MJ/kg to 3.98 MJ/kg, and free-stream Reynolds number varying from 45,900 to 103,000 per meter. The models were cylinders having diameters between 0.05 mm and 11.1 mm and a 1.6-mm-thick flat plate with a leading-edge radius of 0.8 mm. Transverse impact pressure surveys were made from 2 to 55 diameters downstream of the leading edge. All data were obtained in the merged-flow regime and the test data show that even at the highest Reynolds numbers, significant departures from Rankine-Hugoniot shock relations are present. The data indicate, in terms of Mach number and Reynolds number, the leading-edge radius at which a body may be considered sharp; that is the test conditions are defined where the leading edge was sufficiently small so that a measurable shock was not produced. This condition occurred when the cylinder radius was approximately equal to one mean-free-path length. Author

N71-12216 Cincinnati Univ., Ohio.

EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE NEAR WAKE BEHIND A REARWARD FACING STEP IN SUPERSONIC FLOW

Howard Edwin Smith (Ph.D. Thesis) 1969 130 p Avail: Univ. Microfilms. HC \$6.20/Microfilm \$3.00 Order No. 70-4275

The experimentally measured heat transfer distribution along the reattachment surface downstream of the step is also presented. An extension experimental program was conducted using a water-cooled model in a 40 inch x 40 inch continuous-run wind tunnel facility, thus permitting steady state conditions to be obtained for each model configuration and flow condition. The test model was 9 inches wide and was constructed so that the step height could be adjusted to 0.0 (flat plate condition), 0.443 and 0.750 inches. The model was instrumented with surface pressure orifices and steady state heat transfer gauges. Specially designed probes were used to measure the properties of the flow. Tests were conducted at free stream Mach numbers of 2.5, 3.5 and 5.0 over a range of Reynolds numbers based on length of surface upstream of separation from approximately 250,000 to 1,800,000. Several representative flow fields are presented, along with analyses of the various regions of these fields. Dissert. Abstr.

N71-12217* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

LIFTING BODY Patent Application

William T. Holmes, inventor (to NASA) Filed 4 Feb. 1970 3 p (NASA-Case-FRC-10063; US-Patent-Appl-SN-21263) Avail: NTIS CSCL 01C

Design drawings depict a delta shaped lifting body with thickened, almost conical center and flat triangular side wings. Shown are top and bottom plans, side and elevational views, and also a perspective view of the new design. NASA

N71-12218* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ACOUSTIC PROPERTIES OF A SUPERSONIC FAN

A. W. Goldstein, F. W. Glaser, and J. W. Coats [1970] 17 p refs Presented at the 9th Aerospace Sci. Meeting, New York, 25-27 Jan. 1971; sponsored by AIAA (NASA-TM-X-52937) Avail: NTIS CSCL 20D

The acoustic properties of a supersonic fan of short blade length are discussed. Measurements were obtained with and without stator blades to provide control of wake-chopping and other blade row interference effects. Both internal and external measurements show a relation between the internal shock wave configuration and the intensity of the radiated sound. Substantial variations in the flow conditions at each blade of a homogeneous blade row provide an obvious source of the observed pure tone system based on multiples of the rotational speed of the shaft. Author

N71-12219* Scientific Translation Service, Santa Barbara, Calif.
COMPUTATION OF THE PRESSURE FIELD INDUCED BY THE OSCILLATION OF A CONTROL SURFACE IN SUBSONIC FLOW [CALCU DU CHAMP DE PRESSION INDUIT PAR L'OSCILLATION D'UNE GOUVERNE EN ECOULEMENT SUBSONIQUE]

R. Dat et al Washington NASA Nov. 1970 17 p refs Transl. into ENGLISH from Rech. Aerospatiale (Paris), no. 2, Mar.-Apr. 1970 p 121-126 (Contract NASw-2035)

(NASA-TT-F-13385) Avail: NTIS CSCL 01A

The computation of pressure induced by control surface oscillation is discussed. The method is based on the analysis of the matrix solution to the lifting surface problem and on the expression of pressure distribution in the vicinity of lines of singularity. Application to the rectangular airfoil has given satisfactory results in the sense that convergence is good as a function of the number of components retained in the pressure expansion. Author

N71-12221# Institut Franco-Allemand de Recherches, St. Louis (France).

APPLICATION OF THE SCHLIEREN PROCESS TO THE DENSITY MEASUREMENT ON HYPERSONIC WAKES IN THE FREE FLIGHT TUNNEL [METHODES STRIOSCOPIQUES DE MESURE DES MASSES VOLUMIQUES DANS LES SILLAGES HYPERSONIQUES EN TUNNEL DE TIR]

P. Smigielski, L. Oudin, A. Kalt, F. Albe, M. Devaud et al 5 Mar. 1969 29 p refs In FRENCH (ISL-T-12/69) Avail: NTIS

Geometrical and physical parameter effects of an optical schlieren system with double fringes and double penetration on phase observations in the wake of a hypervelocity projectile traveling through the atmosphere at low pressure, are studied. Optimization of instruments for measuring light diffraction considers photographic emulsion sensitivity. Obtained light diffraction values are used to calculate the distribution of diffractive indices by a linearization method if the step-wise continuing distribution has a symmetrical rotation axis; an example calculation is included (entropy wake). The application of holography in free flight tunnels is outlined. Author

N71-12223# Institut Franco-Allemand de Recherches, St. Louis (France).

OPTICAL METHODS APPLIED IN THE FREE FLIGHT TUNNEL [LES METHODES OPTIQUES APPLIQUEES AU TUNNEL DE TIR]

P. Smigielski, H. Royer, and F. Albe 1 Oct. 1969 30 p refs
In FRENCH
(ISL-T-39/69) Avail: NTIS

Classical holographic methods are briefly described and the experimental evaluation of the following optical holographic methods are outlined: (1) hologram analysis by laser schlieren photography with phase plate defocusing (this gives a phase shift of 180 deg in a half-plane); and (2) flow visualization of hypervelocity sphere wakes by differential interferometry with polarized light and laser schlieren method with amplitude subtraction. Author

N71-12224* National Aeronautics and Space Administration, Electronics Research Center, Cambridge, Mass

THE USE OF AUTOMATIC CONTROL THEORY AND A PILOT MATH MODEL IN HELICOPTER MANUAL CONTROL SYSTEM SYNTHESIS

Paul S. Rampfer, Lloyd Stevenson, and Dennis Collins Oct 1968 18 p

(NASA-TM-X-66492, PM-64) Avail: NTIS CSCL 01A

An investigation into the use of automatic control theory with a simple pilot model for synthesizing helicopter landing approach flight director control laws was made. The synthesis technique was successful and was subsequently used to define flight director control laws for the Langley Research Center CH-46C tandem rotor helicopter. Author

N71-12225* National Aeronautics and Space Administration, Electronics Research Center, Cambridge, Mass

TWO SETS OF LINEARIZED AIRCRAFT EQUATIONS OF MOTION FOR CONTROL SYSTEM ANALYSIS

Paul S. Rampfer and Lloyd Stevenson Aug 1968 20 p refs
(NASA TM-X-66493, PM-56) Avail: NTIS CSCL 01A

In developing a mathematical model for a tandem rotor helicopter to use in the analysis of an automatic approach and landing system, linearized equations not normally used in aircraft along with those normally used. Author

N71-12226* Carleton Univ., Ottawa (Ontario) Div of Aerothermodynamics

A COMPUTER PROGRAM FOR THE ANALYSIS AND DESIGN OF THE FLOW IN TURBOMACHINERY. PART B: LOSS AND DEVIATION CORRELATIONS

W. R. Davis Jul 1970 113 p refs
(ME/A-70-1) Avail: NTIS

A computer program is described which calculates design (or minimum loss) and off-design total pressure loss coefficient and deviation angle for a given blade geometry and inlet air angle. A number of options are provided for the user regarding the method used to make the calculations, and the particulars of the various options are included. A test case with sample input and output and the FORTRAN listings are provided. Author

N71-12227* General Motors Corp., Indianapolis, Ind
EXPERIMENTAL INVESTIGATION IN AN ANNULAR CASCADE SECTOR OF HIGHLY LOADED TURBINE STATOR BLADING. 5: PERFORMANCE OF TWO TANGENTIAL JET BLADES

James L. Bettner Washington NASA Nov. 1970 167 p refs
(Contract NAS3-9404)

(NASA CR-1675, EDR 5315) Avail: NTIS CSCL 21E

Two low reaction tangential jet turbine stator blade configurations were tested in a six blade annular cascade. A plain blade, designed to the same aerodynamic requirements, was tested for performance comparison. The two tangential jet configurations

differed by and were identified by the axial position of the jet slot. The slot was located at approximately 38 percent of the axial chord for the number 1 blade and at about 57 percent for the number 2 blade. The tangential jet blade surface contours were identical to the plain blade, except in the aft suction surface region which was modified to accommodate the jet slots. Three jet slot sizes of 0.020, 0.030, and 0.040 inch with three secondary flow rates for each slot were investigated for both number 1 and 2 blades. Secondary flow rates of up to nearly 7.5 percent of the primary flow were investigated. All configurations were tested at the design values of inlet gas angle and Mach number. Author

N71-12230* School of Aerospace Medicine, Brooks AFB, Tex.
NOISE ASSOCIATED WITH OPERATION OF AIR FORCE OV-10A AIRCRAFT Final Report, Apr. May 1970

Donald C. Gasaway Aug 1970 20 p refs

(AD-712667, SAM-TR-70-51) Avail: NTIS CSCL 20/1

Noise measurements are described for near-field positions during engine-starting and pre-takeoff phases of the OV-10A aircraft. The internal noise environment during various phases of ground and airborne operations is described and illustrated. Features of aeromedical importance are emphasized. Author (TAB)

N71-12231* Aeronautical Systems Div., Wright-Patterson AFB, Ohio

LANDING GEAR SYSTEM ANALYSIS

David Bruce Tremblay Mar. 1970 87 p

(AD-712661, ASD-TR-69-113) Avail: NTIS

This report utilizes a matrix format to conduct an analysis of the basic functions of the landing gear system. The interplays of components are identified and the contribution which each component makes in the completion of the function is defined. The analysis is further expanded into a detailed component analysis identifying the modes of failure and physical characteristics brought into play in the completion of each function. These observations are then collated and trends are noted. Potential improvements and needs are defined for future development methods. Author (TAB)

N71-12232* Georgia Univ., Athens, Dept. of Zoology

RADAR TECHNIQUES FOR AIR FORCE APPLICATIONS IN AVOIDANCE OF BIRD-AIRCRAFT COLLISIONS AND IMPROVEMENT OF FLIGHT SAFETY Final Report

S. A. Gauthreaux, Jr. 1 Aug. 1970 7 p refs
(Grant AF-AFOSR-1879-70)

(AD-712720, AFOSR-70-2487TR) Avail: NTIS CSCL 6/3

The report describes the results of a study using United States Weather Bureau WSR-57 radar on the density and timing of migratory flights of birds in and through the southern United States, the orientation of migratory flights and the effects of various weather factors on the orientation process, and the role of bird migration in weather forecasting. The area of investigation provided needed data on migratory movement of birds in an effort to reduce the potential hazards posed to military aircraft by these migrations. The simultaneous weather data gathered during the study were correlated with the migratory movements in an attempt to understand the influence of meteorological factors on bird migration. These data are being analyzed for publication. Author (TAB)

N71-12233* National Aeronautical Establishment, Ottawa (Ontario)

A NOTE ON THE LOADS IMPOSED ON FIXED-WING LIGHT AIRCRAFT DURING AGRICULTURAL OPERATIONS

Richard Sewell 31 Aug. 1970 30 p refs
(LTR-ST.422) Avail: NTIS

The available published information on the flight and ground loads to which fixed-wing light aircraft are subjected during agricultural operations is summarized. Mathematical formulas are developed which may be used to obtain estimates of the total fatigue damage resulting from any combinations of mean stress, stress increment per g, number of flight hours, and frequency of ground-air-ground cycles per flight hour. It is shown that the fatigue damage resulting from the loads imposed during taxiing on rough surfaces may be two orders of magnitude greater than that resulting from the average-case flight loads experience. Author

N71-12234*# Scientific Translation Service, Santa Barbara, Calif.
ATMOSPHERIC REFRACTION AND REFLECTION IN SONIC BOOMS [REFRACTION ATMOSPHERIQUE ET REFLEXION AU SOLDES BANGS]

C. Thery Washington NASA Dec. 1970 22 p refs Transl. into ENGLISH of AGARD Proceedings on Aircraft Engine Noise and Sonic Boom, no. 42, May 1969

(Contract NASw-2035)

(NASA-TT-F-13409) Avail: NTIS CSCL 20A

A new analytical method is applied to the atmospheric refraction of weak intensity repeater shock waves. The results are in excellent agreement with the flight analysis of Jericho. Experimental shock tube studies reported here are considered less conclusive. Author

N71-12235*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

A COMPARISON OF AIRCRAFT AND GROUND VEHICLE STOPPING PERFORMANCE ON DRY, WET, FLOODED, SLUSH-, SNOW-, AND ICE-COVERED RUNWAYS Final Report

Thomas J. Yager, W. Pelham Phillips, Walter B. Horne, and Howard C. Sparks (Aeron. Systems Div.) Washington Nov. 1970 197 p refs Sponsored in part by USAF

(NASA-TN-D-6098; L-7565) Avail: NTIS CSCL 01B

A joint USAF-NASA research program has studied the stopping performance of an instrumented C-141A four-engine jet transport and several instrumented ground vehicles on 50 runways in the United States and Europe under dry, wet, flooded, slush, snow, and ice conditions. It is shown that measurement of the stopping distance of a diagonal-braked ground vehicle provides a meaningful measure of the slipperiness of a wet runway, and permits accurate prediction of the stopping distance of an aircraft under varied runway slipperiness conditions as well as a means for realistic calculation of crosswind limitations. It is also shown that aircraft stopping performance on a wet runway can be considerably improved either by grooving the runway or by use of a porous surface course. Author

N71-12236# Boeing Co., Philadelphia, Pa. Vertol Div.
EVALUATION OF GEARED FLAP CONTROL SYSTEM FOR TILTWING V/STOL AIRCRAFT

G. B. Churchill 11 Aug. 1970 109 p refs
 (AD-712645; D8-2076) Avail: NTIS CSCL 1/3

The geared flap control system provides a means for controlling a tiltwing V/STOL aircraft in hover and transition flight without the use of auxiliary systems such as cyclic propeller pitch or tail jets/rotors. The system is based on using the flap as an aerodynamic servo to position the wing relative to the fuselage. Although the system is mechanically simple, the control characteristics are difficult to visualize because of the coupled body dynamics involved. Therefore, a comprehensive analytical and model testing program was performed to evaluate the system. Author (TAB)

N71-12237 Northwestern Univ., Evanston, Ill.
A FEASIBILITY STUDY OF V/STOL AIR TRANSPORTATION IN THE APPALACHIAN REGION: A CONCEPTUAL FRAMEWORK AND EXAMPLE ANALYSIS

Everett Charlie Carter (Ph.D. Thesis) 1969 293 p
 Avail: Univ. Microfilms: HC \$13.30/Microfilm \$3.80 Order No. 70-23

The feasibility of a major transportation innovation in a region was studied. The attempt was to study the factors involved in an air transportation system and to develop an approach to the systems study of a regional air transportation system; and to use the methodology developed to study the feasibility of introducing vertical or short take off and landing (V/STOL) air transport in the Appalachian region. By developing a decision diagram for transportation in the Appalachian Region, it was determined that the objective of this research in studying the feasibility of V/STOL was within the regional goals of improving the economy of the region. In order to keep the study manageable, West Virginia was chosen as representative of the region. A study of existing and projected technology led to the selection of short take-off and landing (STOL) vehicles for detailed study. Two types of systems were formulated as realistic for West Virginia; they both included a jet airport at Charleston and feeder airports at other cities. The first type of system would have the feeder airports served by STOL aircraft and the second type would use conventional take-off and landing (CTOL) aircraft to serve the feeder airports. Dissert. Abstr.

N71-12238# Vereinigte Flugtechnische Werke G.m.b.H., Bremen (West Germany).

AIRCRAFT WESERFLUG Bf 163 D-IUCY [VERBINDUNGSFLUGZEUG WESERFLUG Bf 163 D-IUCY]

Hans Justus Meier 1970 53 p refs In GERMAN //s Flugzeug-Monografie Nr. 3

Avail: NTIS

The history of the Weserflug Bf 163 aircraft is described. Details are given on the reconstruction of a model of this light liaison aircraft. ESRO

N71-12239*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

WIND-TUNNEL INVESTIGATION OF A FOUR-ENGINE EXTERNALLY BLOWING JET-FLAP STOL AIRPLANE MODEL

Raymond D. Vogler Washington Dec. 1970 86 p refs
 (NASA-TN-D-7034; L-7546) Avail: NTIS CSCL 01A

The low speed longitudinal aerodynamic characteristics of a model of a four engine externally blowing jet-flap STOL aircraft are discussed. Data were obtained at low speeds over a moving ground plane through a model angle of attack range, various model heights, flap deflections, and momentum coefficients for high wing and low wing configurations. Results over the moving and the fixed ground plane show few differences for the high wing configuration except for small increments of forces and moments at the higher blowing momentum coefficients. Author

N71-12240# Boeing Scientific Research Labs., Seattle, Wash.
JET NOISE SUPPRESSION BY AN IMPEDANCE SHROUD

Ian S. F. Jones Jun. 1970 26 p refs
 (AD-712406; DI-82-0984) Avail: NTIS CSCL 20/1

Jet noise can be attenuated by shielding the observer from the noise sources with a sheet of fluid having a different acoustic impedance to the undisturbed atmosphere. The attenuation due to a heated sheet of gas lying on an arc centered on the axis of a subsonic jet was measured. The maximum noise reduction in certain frequency bands in this experiment was 10 dB. Author (TAB)

N71-12241# Federal Aviation Administration, Washington, D.C.
Flight Standards Service

PILOTS WEIGHT AND BALANCE HANDBOOK

1969 74 p
 (FAA-AC-91-23) Avail: SOD \$0.70; NTIS

The importance of weight and balance control as it relates to aircraft safety is discussed. An instruction manual for computing and solving weight and balance problems for various types of aircraft is presented. Pertinent FAA regulations, publications, and advisory circulars which have an impact upon weight and balance procedures are considered in the development of the text.

Author

N71-12242# Oak Ridge National Lab., Tenn.

DESIGN AND DEVELOPMENT OF A STABILIZED BALLOON GONDOLA FOR AN ASTRONOMICAL GAMMA RAY SPECTROMETER

T. J. Golson Aug. 1970 47 p

(Contract W-7405-ENG-26)

(ORNL-TM-2882) Avail: NTIS

A stabilized balloon gondola was designed to lift a 1500-lb gamma ray spectrometer to an altitude of 100,000 ft and orient it to measure gamma rays from outer space. An overhead bearing assembly was designed to uncouple the gondola from the rotation of the balloon, and a gas jet reaction system was used to orient the gondola with respect to the target to be tracked. Preflight tests were conducted on individual components of the gondola and on the gondola as a unit. The tracking accuracy and functional capability of the unit were tested in actual flight and it was determined that the gondola can be successfully launched and recovered with a minimum of damage.

Author

N71-12243* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

SUPERSONIC AIRCRAFT Patent

Augustine W. Robins, Roy V. Harris, Jr., Harry W. Carlson, Francis E. McLean, and Wilbur D. Middleton, inventors (to NASA) Issued 21 Mar. 1967 (Filed 21 May 1965) 7 p Cl. 244-45

(NASA-Case-XLA-04451; US-Patent-3,310,262;

US-Patent-Appl-SN-457876) Avail: US Patent Office CSCL 01C

The design is described of a supersonic aircraft having fixed substantially arrow-wing planform configurations and considered to be particularly useful for application to civilian and military transport or military surveillance and bombardment aircraft. The stated benefits of the proposed aircraft design include: (1) provides a new and improved fixed, swept-wing planform; (2) utilizes wing areas of receding slope to provide maximum utilization of the inherent nacelle-wing airflow interference; (3) provides an improved planform in which a twisted and cambered wing is utilized for maximizing supersonic flight efficiency; and (4) provides a novel aircraft configuration in which the wing fuselage-nacelle combination is self-trimming and the drag-due-to-lift is considerably lower than that of a low-sweep flat wing configuration of conventional aircraft.

D. L. G.

N71-12244*# National Aeronautics and Space Administration, Electronics Research Center, Cambridge, Mass.

ERC V/STOL PROGRAM FLIGHT TEST PLAN. H-19 FLIGHT PROGRAM PHASES 1A AND 1B, WALLOPS STATION, VIRGINIA

May 1968 77 p

(NASA-TM-X-66494; PM-51) Avail: NTIS CSCL 01A

The general flight test plan for the first two phases of the H-19 flight test program is presented. The test program is described and guidelines are established for the detailed plans which will be documented in the procedures and operations manuals. The major flight test objective is to obtain experimental data on an aided inertial system for terminal guidance and navigation of a helicopter for use in designing a V/STOL avionics system. This plan defines: detailed objectives, success criteria, testing approach, system and instrumentation descriptions, flight profiles, test descriptions, facilities, data recovery, post-flight analysis, and schedules.

Author

N71-12245*# Translation Consultants, Ltd., Arlington, Va.

THE INFLUENCE OF POROSITY ON THE PERFORMANCE AND PROPERTIES OF PARACHUTES [DER EINFLUSS DER POROSITAET AUF LEISTUNG UND EIGENSCHAFTEN VON FALLSCHIRMEN]

H.-D. Melzig Washington NASA Sept. 1969 21 p refs Transl. into ENGLISH from German Aero- and Astron., Lectures at the DFVLR Inst. of Aerodynamics at the DGLR-DFVLR-AGARD Symp. on Parachutes and Rescue Systems (Braunschweig), 15-19 Sep. 1969

(Contract NASw-2038)

(NASA-TT-F-13431) Avail: NTIS CSCL 11E

The definitions for air permeability and porosity are explained. Results of air permeability measurements for a variety of cloth at differential pressures from 0 to 500 mm H₂O are reported. An empirical formula for the calculation of air permeability at any differential pressure in this range is given. The influence of porosity of the parachute canopy on canopy shape and filling on opening forces, filling time, and stability is reported. The influence of air density on porosity is discussed.

Author

N71-12246# Institut Franco-Allemand de Recherches, St. Louis (France).

INTERACTION BETWEEN AIRCRAFT BOOM AND OBSTACLES. PART 2: STUDY OF THE REFLECTION OF AN AIRCRAFT BOOM IN A VALLEY BASIN [INTERACTION ENTRE BANGS ET OBSTACLES. 2EME PARTIE: ETUDE DE LA REFLEXION D'UN BANG DANS UN FOND DE VALLEE]

C. Thery, A. Peter, and M. Pfister 10 Mar. 1970 64 p refs In FRENCH

(ISL-T-9/70) Avail: NTIS

N-wave reflection from the walls of a deep valley basin is analyzed by representing the reflecting plane schematically as the segment of a circular cylinder. Studied is the reflection from an infinite semicircular cylindrical plane (two-dimensional analysis) by applying shadow photography and interferograms to determine wave structure in the vicinity of the caustic surface as well as the geometrically limited development of high overpressure in the vicinity of the triple point in the developed Y. Evaluation of the pressure field provides the U-shape of the reflected pressure signature and the important amplitudes of the pressure points in the vicinity of the focus. A three-dimensional reflection study in a valley basin having walls of infinite heights provides that at a small (or high) incidence angle wave reflection corresponds to results from two-dimensional calculations. At incidence angle of about 30 deg, focusing is only obtained when the valley basin is so deep that three-dimensional effects develop immediately after passage of reflecting wave fronts with only brief pressure peak developments. It is assumed that limiting shock front development times and irregular shape of natural topography level pressure peaks of aircraft booms.

Transl. by G. G.

N71-12247# Institut Franco-Allemand de Recherches, St. Louis (France).

INTERACTION BETWEEN AIRCRAFT BOOMS AND OBSTACLES. PART 1: RESEARCH TECHNIQUES AND THEIR APPLICATION TO THE INVESTIGATION OF THE ENVELOPE OF A STRUCTURE [INTERACTIONS ENTRE BANGS ET OBSTACLES. 1ERE PARTIE: TECHNIQUES D'ETUDE ET APPLICATION A L'ETUDE DE L'ENVELOPPEMENT D'UNE CONSTRUCTION]

C. Thery, A. Peter, and M. Pfister 11 Feb. 1970 85 p refs In FRENCH

(ISL-T-2/70) Avail: NTIS

The performance of N-wave generator, based on the functional principle of a variable cross section shock tube, is considered for application in laboratory model studies on interactions between airplane booms and obstacles. Investigated are the effects of sonic boom at various angles of incidence on the shell of a building. Shell

phases are described qualitatively, and if possible quantitatively. Results are compared with measurements obtained at various building sides. Finally, the overall effective load for the structure is determined; shadow photographs and interferometers of the process are shown. Author

N71-12248# Advisory Group for Aerospace Research and Development, Paris (France). Flight Mechanics Panel.

V/STOL HANDLING QUALITIES CRITERIA. 1: CRITERIA AND DISCUSSION

Dec. 1970 50 p refs Revised

(AGARD-R-577-70) Avail: NTIS

Criteria on handling qualities for VTOL and STOL aircraft are presented. Included with each criterion is a discussion pointing out the pilot's reasons for including a particular handling quality feature. The criteria are based on results of tests using piloted ground-based simulators, variable stability aircraft, particular models of VTOL and STOL aircraft, and variable stability helicopters. Author

N71-12386# National Aviation Facilities Experimental Center, Atlantic City, N.J.

EXPERIMENTATION SUPPORT FOR DEVELOPMENT OF LOW COST TV RADAR REMOTING SYSTEM Final Report, Jul. 1968 - Feb. 1970

Max Greenberg Dec. 1970 82 p refs

(FAA-NA-70-52; FAA-RD-70-74) Avail: NTIS

Test and experimentation were conducted on an engineering model microwave relay remoting system to obtain data to finalize the system design requirements. Measurements and calculations for received signal levels, fade margins, signal plus noise-to-noise ratio, noise figure and others were obtained. Measured values of the signal levels for a dish-to-dish antenna configuration were in agreement with the theoretical values, whereas the measured values for the periscope antenna configuration used showed a 5 dB discrepancy to the predicted values. An analysis of this discrepancy is covered in the report. In general, the microwave receiver and transmitter characteristics met the equipment procurement specifications. Author

N71-12400# National Academy of Sciences-National Research Council, Washington, D.C. Committee on Hearing, Bioacoustics, and Biomechanics.

SONAR DETECTION OF SUBMARINES BY HELICOPTER

Aug. 1970 11 p

(Contract Nonr-2300(05))

(AD-711910) Avail: NTIS CSCL 20/1

The report advises the military services concerning means for improving the efficiency of the search technique of sonar operators and crew members involved in searching for submarines by means of helicopter-borne equipment. Measures are also suggested for protecting the hearing of the sonar operator and the crew of the helicopter. Author (TAB)

N71-12416*# Translation Consultants, Ltd., Arlington, Va.
THE HISTORICAL DEVELOPMENT OF ROCKETS AND THE PURPOSE AND LIMITS OF TECHNOLOGY [DIE GESCHICHTE DER RAKETENENTWICKLUNG UND UEBER SINN UND GRENZEN ALLERTECHNIK]

Fritz von Opel Washington NASA Dec. 1970 34 p Transl into ENGLISH from German Rept. Presented at the German Museum, Munich, 3 Apr. 1968

(Contract NASw-2038)

(NASA-TT-F-13436) Avail: NTIS CSCL 19G

The earliest development of rockets and their use in both the ancient East and West are discussed. The decline and subsequent

revival of rocket research is considered, with emphasis given to the work of the author. The limits of all technology are examined and future trends in its future development are given. R.B.

N71-12421*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

EXPERIMENTAL PERFORMANCE OF A MODULAR TURBOJET COMBUSTOR BURNING NATURAL GAS FUEL

Nicholas R. Marchionna and Arthur M. Trout Washington Dec. 1970 25 p refs

(NASA-TN-D-7020; E-5740) Avail: NTIS CSCL 21E

A swirl-can modular combustor was tested with natural gas fuel. The rectangular combustor array simulated a 90 deg sector of a turbojet engine combustor. The combustor was tested at an inlet air pressure of 45 psia (31 N/sq cm), inlet air temperatures of 600 and 1200 F (589 and 922 K), and inlet Mach numbers of 0.24 and 0.31. Combustion efficiency was close to 100 percent at an average exit temperature of 2200 F (1480 K). Exit temperature distribution was excellent. At an inlet Mach number of 0.24, the pattern factor was 0.15 for a nominal inlet temperature 600 F (589 K) and 0.11 for a nominal inlet temperature of 1200 F (922 K). Total pressure loss was approximately 6.3 percent for an inlet Mach number of 0.30 and temperature ratio of 1.7. Author

N71-12422*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

EFFECT OF SHORTENING TRANSITION LINER TO DECREASE OVERALL LENGTH OF A RAM INDUCTION COMBUSTOR

Donald F. Schultz, Porter J. Perkins, and Jerrold D. Wear Washington Dec. 1970 20 p refs

(NASA-TN-D-7021; E-5691) Avail: NTIS CSCL 21E

The change in performance of a 40-inch (102-cm) diameter turbojet combustor, originally 30 inches (76 cm) long, was determined when it was shortened 5.0 inches (12.7 cm) at the discharge end. Design was for Mach 3.0 cruise inlet-air conditions of 90-psia (62-N/sq cm) total pressure and 1150 F (839 K) inlet-air temperature with an airflow rate of 108.6 lb/sec (49.3 kg/sec). The reduced length caused pattern factors to double (0.22 to 0.40), exit average circumferential temperature profiles to deteriorate, and efficiency to decrease slightly from 100 percent. Total pressure loss, exit average radial temperature profile, and smoke were not affected. Author

N71-12425*# National Aeronautics and Space Administration, Electronics Research Center, Cambridge, Mass.

APPLICATION OF LASER TECHNOLOGY TO GEODETIC MEASUREMENTS AND MAPPING Technical Summary Report

Janis Bebris Apr. 1968 22 p refs

(NASA-TM-X-66489; PM-46) Avail: NTIS CSCL 20E

Available background information on laser altimeter-rangefinder techniques was updated. The commercially available laser rangefinder-altimeter systems, systems presently under development, and some advanced concepts and techniques are described. Author

N71-12426# Advisory Group for Aerospace Research and Development, Paris (France).

AIRCRAFT LANDING SYSTEMS

Cornelius T. Leondes, ed. Sep. 1970 299 p refs Presented at Symp. of the Guidance and Control Panel of AGARD, Cambridge, Mass., 20 - 23 May 1969

(AGARD-CP-59-70) Avail: NTIS

Conference papers are presented on needs and requirements, system details, flight experience, and technical hardware of ILS and automatic landing systems for conventional and V/STOL aircraft.

N71-12427# Board of Trade, London (England).

ALL WEATHER LANDING

O. B. St. John /in AGARD Aircraft Landing Systems Sep. 1970 6 p

Avail: NTIS

Problems encountered in low visibility landings by flight crews and with automatic landing systems are discussed. Several solutions are proposed and include: replacing the ILS system with a new system, supplementing ILS with an independent monitor, and using an inertial crutch. The reliability problems of automatic landings are also discussed. A landing measurement system was developed as an aid in solving the problems. E.H.W.

N71-12429# Instrument Pilot Instructor School (ATC), Randolph AFB, Tex.

PSYCHOLOGICAL AND PROCEDURAL ASPECTS RELATED TO ILS APPROACHES AND LANDINGS IN VISIBILITIES LESS THAN 1200 FEET

Edwin W. Johnson, Donald L. Carmack, and Larry M. Hadley /in AGARD Aircraft Landing Systems Sep. 1970 10 p

Avail: NTIS

The pilot control-display factors program was conducted to define the pilot's flight control-display requirements and to demonstrate solutions for flying on instruments from letdown through approach and landing. The procedural and psychological adjustments of pilots in different operational environments are discussed. E.H.W.

N71-12430# Litchford Systems, Northport, N.Y.

NEW DEVELOPMENTS IN LANDING SYSTEMS

G. Litchford /in AGARD Aircraft Landing Systems Sep 1970 5 p refs

Avail: NTIS

The system synthesis approach to developing new landing systems is described, emphasizing communication equipment. Both military and civil aviation are considered. Changes and requirements of a landing system to meet the needs of high performance of modern aircraft are proposed and include: (1) operational requirements, (2) flight dynamic requirements, (3) selection of radio frequency, (4) bandwidths, (5) data rates, and (6) modulation characteristics. E.H.W.

N71-12431*# Massachusetts Inst. of Tech., Cambridge Instrumentation Lab.

AUTOMATIC LANDING SYSTEM OPTIMIZATION USING INERTIAL NAVIGATION DATA AND MODERN CONTROL THEORY

Duncan MacKinnon /in AGARD Aircraft Landing Systems Sep 1970 16 p refs
(Contract NAS12-602)

(NASA-CR-111575) Avail: NTIS CSCL 17G

Conventional automatic landing systems utilize information provided by the Instrument Landing System (ILS) as the primary position reference during the acquisition and approach phases. The ILS position data is characterized by high noise level due to irregularities in the ILS signal structure as a result of reflections from objects on the ground illuminated by the ILS transmitter antennas. The high noise level filters required to reduce it to an acceptable level, stability and saturation constraints place significant

limitations on the ability of the conventional landing system to resist the effects of environmental disturbances. Improved performance may be achieved by combining data from the ILS and an onboard inertial navigator. The resultant position, velocity, and lagged acceleration information is essentially free from noise. As a result a new control system configuration featuring improved accuracy and resistance to disturbances may be constructed and its performance compared to that of a conventional system. Author

N71-12432# Sperry Rand Corp., Phoenix, Ariz. Flight Systems Div.

IMPORTANCE OF SPEED CONTROL RELATIVE TO LONGITUDINAL TOUCHDOWN DISPERSION

R. G. Looime /in AGARD Aircraft Landing Systems Sep. 1970 12 p

Avail: NTIS

The effects of radio altimeter errors, aircraft position errors, and wind on the flare initiation point, rate of descent at touchdown and longitudinal dispersion using a fixed parameter, and exponential flare trajectory are illustrated. These same effects are illustrated simultaneously with changes in reference airspeed and changes in glide slope beam angles. The effect of changing parameters of the flare control law is discussed. The data presented demonstrate that the effect of reference airspeed changes on touchdown and flare initiation altitude dispersions can be reduced by varying the touchdown rate-of-descent parameter in the flare control law as a function of reference airspeed. It is further demonstrated that variation of the flare control law as a function of reference air speed and flight path angle (with respect to the air mass) can eliminate dispersion resulting from reference airspeed and glide slope beam angle changes, and minimize dispersion resulting from wind conditions. The use of reference airspeed and flight path angle parameter control would depend upon rigid speed and path control while tracking the glide slope beam and minimum interaction between the speed and path control subsystems. This can best be accomplished with the consistency of automatic systems. Author

N71-12433# Federal Aviation Administration, Washington, D.C.
NEW GUIDANCE DEVELOPMENTS FOR ALL WEATHER LANDING

David J. Sheftel /in AGARD Aircraft Landing Systems Sep 1970 9 p

Avail: NTIS

Feasibility developments to satisfy current and anticipated needs of civil and military airports are discussed. These developments include fixes for current landing systems as well as totally new techniques to replace and/or supplement current equipment. To fully evaluate what alternatives are most responsive to need, there is a joint concerted effort by civil government, military, and aircraft operator groups to define operational requirements and to determine what maximum degree of commonality can be achieved toward a standard modular system for common use. Author

N71-12434# Smiths Industries, Ltd., Cheltenham (England) Aviation Div.

DEVELOPMENT OF AIRBORNE HARDWARE FOR AUTOMATIC LANDING SYSTEMS

R. I. Bishop /in AGARD Aircraft Landing Systems Sep 1970 13 p refs

Avail: NTIS

The design, manufacture, and tests of an autopilot system are discussed. Redundancy forms for fail-operational and fail-safe capabilities of the system, and modifications to improve autopilot performance are described. E.H.W.

N71-12435# Airborne Instruments Lab., Deer Park, N.Y.

POST-1970 SCANNING BEAM APPROACH AND LANDING

Joseph E. Woodward / In AGARD Aircraft Landing Systems Sep. 1970 13 p refs

Avail: NTIS

A brief review covering the system design and flight test programs of the scanning beam is given. The FAA system is used to illustrate the basic concepts and their application to a full scale system. The systems developed for different applications are described, and flight test results are given. Author

N71-12436# Royal Aircraft Establishment, Farnborough (England).

LANDING VTOL AIRCRAFT IN ADVERSE CONDITIONS AND SOME POSSIBLE SOLUTIONS

D. J. Walters / In AGARD Aircraft Landing Systems Sep. 1970 10 p

Avail: NTIS

Flight trials were carried out on an unstabilized P-1127 vectored thrust aircraft flown into a restricted site by night to give first hand experience to the pilot under adverse conditions. It was determined that the pilot needs a fairly accurate knowledge of position relative to landing site to get the best operational advantage. The tracking method proposed for obtaining angular information is based on the interferometer principle and a solid state microwave power source. The flight maneuvers, and the airborne and ground equipment are discussed. N.E.N.

N71-12437# Centre d'Essais en Vol, Bretigny-Sur-Orge (France).

EXPERIENCE OF THE FRENCH FLIGHT TEST CENTER IN THE AREA OF ALL WEATHER LANDING [EXPERIENCE DU CENTRE D'ESSAIS EN VOL FRANCAIS DANS LE DOMAINE DE L'ATTERRISSAGE TOUT TEMPS]

Y. Michot / In AGARD Aircraft Landing Systems Sep. 1970 4 p In FRENCH

Avail: NTIS

Results of flight tests of the all-weather landing system are presented. Tests were made on the M.S. 760, Nord 262, and Caravelle aircraft. The results verify the importance of certain altitudes: 100 feet, 50 feet, 15 feet, and touchdown. It was found that it is not necessary to double systematically the automatic pilots to have a safe approach and landing in Category 3A conditions. It is also felt that the safety is always guaranteed by the capability of the pilot to take over control manually. Transl. by E.H.W.

N71-12438# Naval Material Command, Washington, D.C.

AUTOMATIC LANDING SYSTEMS ARE HERE

John L. Loeb / In AGARD Aircraft Landing Systems Sep. 1970 19 p

Avail: NTIS

An automatic landing system was developed for operational use on aircraft carriers and for training ashore. The system enhances all-weather capability and increases flight safety. The system development, problems and solutions, fail-safe and safety features, and hardware and software interfaces are discussed. Author

N71-12439# National Aeronautics and Space Administration, Electronics Research Center, Cambridge, Mass.

AIDED INERTIAL FLIGHT TEST EXPERIMENTS

Ronald J. Madigan and Edmund J. Koenke / In AGARD Aircraft Landing Systems Sep. 1970 16 p

(NASA-TM-X-66490) Avail: NTIS CSCL 17G

The flight program is described which is designed to test navigation, guidance and control system concepts, requirements, flight hardware and software which can make all weather V/STOL

operations technically feasible. The availability of the Gemini space vehicle guidance and communication systems along with the supporting ground systems equipment allowed the opportunity to test, with hardware, those guidance and control concepts which had been studied in relationship to aided inertial systems for aircraft applications. The flight testing was contrived to establish navigation and guidance system performance using radar position data for up-dating in the on-board computer. It is concluded that an improved total navigation capability can be achieved with available technology and that with equipment which is ten years old it is possible to predict the aircraft touchdown point to within a ten foot cross section on the runway. Author

N71-12440# Smiths Industries, Ltd., Cheltenham (England). Aviation Div.

THE DEVELOPMENT OF AUTOMATIC LANDING FOR BEA OPERATION

J. L. Weston / In AGARD Aircraft Landing Systems Sep. 1970 22 p

Avail: NTIS

The in-flight experience of the autopilot system is discussed, and the important stages of the flight trials through to certification demonstrations are traced. Experiences in operating the system installed in commercial planes are also examined. Some of the problems revealed by the trials are examined in detail. Controlling interference on the ILS radio beams is considered to be the major problem requiring solution. A continuing program of pilot training is maintained. Author

N71-12441# Elliott Bros., Ltd., London (England). Transport Aircraft Controls Div.

EXPERIENCE GAINED BY BAC AND ELLIOTT IN THE DEVELOPMENT AND SERVICE USE OF AUTOMATIC LANDING SYSTEMS

M. F. Moulton / In AGARD Aircraft Landing Systems Sep. 1970 19 p

Avail: NTIS

The development of the VC-10 autopilot landing system is discussed. The basic fail-operative configuration, basic integrity and development of in-line monitoring, improved self-monitoring techniques, and pilot displays are described. The flight test program and the problems areas are also considered. It is felt that it is necessary to carry out quite elaborate on-aircraft testing using aerodynamic simulators and dynamic response test equipment to ensure a repeatable standard of performance during flight test. N.E.N.

N71-12442# Lockheed-Georgia Co., Marietta.

THE AUTOPILOT FOR THE C-141 ALL WEATHER LANDING SYSTEM

Thomas L. Cronley and Robert E. Glacken (Bendix Corp., Teterboro, N.J.) / In AGARD Aircraft Landing Systems Sep. 1970 20 p

Avail: NTIS

The basic configuration and operation of the autopilot are discussed. The Autoland system provides tight tracking of the localizer and glide slope beams, wind-shear capability, flare computt computation, and beam gain desensitizing as a function of radar altitude. Redundancy and monitoring, together with a means of testing the approach functions en route, are incorporated in the system. The system condition for a monitored Category 2 approach is determined by the preland test and en route test. Problem areas identified during the flight test program, and resulting modifications to the system are also described. N.E.N.

N71-12443# Air Force Systems Command, Wright-Patterson AFB, Ohio. Flight Dynamics Lab.

DIRECT LIFT CONTROL FOR APPROACH AND LANDING

Robert C. Lorenzetti /in AGARD Aircraft Landing Systems Sep. 1970 17 p refs
 Avail: NTIS

Direct lift control (DLC) is a system which produces lift forces in the direction the pilot desires to move the airplane without significant pitching moment. The DLC enhances precision longitudinal maneuvering capability by providing a change in altitude or rate of climb without a change in pitch attitude and without the initial acceleration reversal, delay in lift build-up, and excessive pitch rate overshoot associated with conventional elevator control. This is accomplished by moving an auxiliary lift surface(s) such as biased spoilers, symmetrically operated ailerons, flaps, or canards in addition to the elevator. The DLC systems can be either blended (responding to normal longitudinal stick movements) or separate (activated by a thumb-wheel or other auxiliary lever). They can be open loop (with fixed ratio interconnect between the elevator and DLC surface) or closed loop (with feedbacks of pitch angle, pitch rate, pitch acceleration, and/or normal acceleration). In general, blended closed loop systems give the best performance but are the most expensive. Additional DLC benefits include reduction in normal acceleration of the aircraft center of gravity, improved handling in turbulence, and reduction in pilot workload. Author

N71-12444# Societe Francaise d Equipments pour la Navigation Aeriennne, Neuilly-Sur-Siene (France).

THE AUTOMATIC PILOT, TAPIR [LE PILOTE AUTOMATIQUE, TAPIR]

M. Pagnard /in AGARD Aircraft Landing Systems Sep. 1970 8 p In FRENCH
 Avail: NTIS

The developmental problems of the automatic pilot TAPIR, are discussed. The pilot, built for category 1 type aircraft, can, with simple material extensions, be utilized for category 2 and 3 type aircraft. The performance capabilities of the automatic pilot are given. Transl. by E.H.W.

N71-12445# Vereinigte Flugtechnische Werke G.m.b.H., Bremen (West Germany).

FLIGHT CONTROL SYSTEMS WITH RESPECT TO V/STOL AUTOMATIC LANDING

H. G. Schumann and R. Staufenbiel /in AGARD Aircraft Landing Systems Sep. 1970 19 p
 Avail: NTIS

Preliminary investigations were carried out for establishing the specification of ground and airborne equipment for instrument and automatic VTOL landings. The problems of optimizing landing profiles, pilot handling, and display systems are discussed, as well as the influences of flight control and automatic flight control systems. The development status of hardware for in-flight simulations of instrument and automatic landings with the hovering test rig are described. Author

N71-12446# Advisory Group for Aerospace Research and Development, Paris (France).

THE LANDING SYSTEM OF THE THOMSON/CSF: LS 371, SATRAM, SYDAC/ILS [SYSTEMES D'ATTERRISSAGE DE THOMSON/CSF: LS 371, SATRAM, SYDAC/ILS]

P. Dautrement /in Aircraft Landing Systems Sep. 1970 15 p In FRENCH
 Avail: NTIS

The equipment and operation problems of the automatic landing systems LS371, STRAM, and SYDAC/ILS of the Thomson/CSF are discussed. Performance, applications, and limitations of the system are given. The systems are used for all-weather landing in civil and military aviation. Transl. E.H.W.

N71-12447# Royal Aircraft Establishment, Farnborough (England).
EVOLUTIONARY EXTENSION OF ILS

J. Benjamin /in AGARD Aircraft Landing Systems Sep. 1970 17 p refs
 Avail: NTIS

Recent VHF ILS research and development and projected future evolution are outlined. The research and development activities include instrumental accuracy, test gear for in-line servicing, operational integrity, weather effects, reliability, airborne antennas, beam calibration, and monitoring. The problem of higher integrity was pursued by four approaches: ground based monitoring and equipment, application of the independent sideband detection technique of the airborne receiver, raising the localizer integrity by special designing, and microwave correlation protected ILS. Hyperbolic correlation is discussed with respect to three areas of future application: integrity of a microwave correlation system providing time and velocity discrimination, low cost ILS with high accuracy and reliability, and terminal area traffic handling. N.E.N.

N71-12448# Sud-Aviation, Blagnac (France).

THE AUTOMATIC LANDING SYSTEM OF THE CONCORDE [LE SYSTEME D'ATTERRISSAGE AUTOMATIQUE DE CONCORDE]

R. Deque /in AGARD Aircraft Landing Systems Sep. 1970 18 p In FRENCH
 Avail: NTIS

After reviewing objectives for the supersonic transport Concorde, the means by which the automatic and general landing systems function in low visibility are examined. Transl. by E.H.W.

N71-12489# Sandia Corp., Albuquerque, N.Mex.

SPLAT: COMPUTER CODE FOR PREDICTION OF HYDROMETEOR IMPACT EROSION ON HIGH-SPEED SPHERE-CONE VEHICLES

James K. Cole and Molly A. Ellis Aug 1970 71 p refs
 (SC-DR-70-373) Avail: NTIS

SPLAT is a FORTRAN 4 computer code that calculates local surface recessions occurring at the stagnation point and at two arbitrary locations on the afterbody of a sphere-cone vehicle as the result of ice and liquid hydrometeor impacts. The shock-layer effects of deceleration and deflection of liquid and ice hydrometeors and of breakup of liquid hydrometeors are included in the formulation. Operation of the code and the mathematical models employed are described. Author

N71-12533# General Electric Co., Binghamton, N.Y. Avionic Controls Dept

BRUSHLESS dc MOTOR Interim Report

B. H. Hertzendorf Nov. 1970 31 p refs
 (Contract NAS8-26213)
 NASA-CR-102942) Avail: NTIS CSCL09C

The motors have split windings which can be connected in either a full-winding or a 1/4-winding configuration. The motors provide up to 5.0 ft-lbs output torque at speeds up to 435 rpm with the full-winding. With the 1/4-winding the motors will operate at 1.25 ft-lbs and at speeds up to 1740 rpm. The motor design was optimized for operation in the 1/4-winding condition. A summary of the brushless dc motor specifications, along with the actual test results are presented. The test results shown are the average values for the two motors. Test data for each motor are also given. Author

N71-12541*# Scientific Translation Service, Santa Barbara, Calif.
STUDY OF A SUPERSONIC COMPRESSOR FOR A CENTRIFUGAL COMPRESSOR [ETUDE DU DIFFUSEUR SUPERSONIQUE D'UN COMPRESSEUR CENTRIFUGE]

A Papon et al Washington NASA Dec. 1970 40 p refs
Transl. into ENGLISH of French Report Presented at the Assoc.
Franc. des Ingr. et Techniciens de l'Aeron. et de l'Espace, 6th
Colloq. d'Aerodynamique Appl., Toulouse, 12 - 14 Nov. 1969
(Contract NASw-2035)

(NASA-TT-F-13428) Avail: NTIS CSCL 13G

The possibility is studied of improving the design of a vane diffuser for a radial flow refrigerator compressor so as to make the diffuser more capable of accepting the high outputs of the compressor wheel. The design of a circular blade cascade in which recompression and flow can take place progressively and with a minimum of losses, regardless of the cascade stagger is discussed. The results of a preliminary investigation using hydraulic analogy to estimate the improvements possible in the diffuser design are presented. It is shown that the improvement of the diffuser performance depends on the reduction of the separation region, which can be achieved by greatly decreasing the angle of opening of the diffuser channels in the downstream direction, by increasing the rate of slow down in the recovery section, and by making the flow in the diffuser neck uniform.

Author

N71-12594# Eurocontrol Agency, Brussels (Belgium).
**OPERATIONAL, TECHNICAL, AND ECONOMIC ASPECTS
OF AN AERONAUTICAL SATELLITE SYSTEM FOR CIVIL
AIR TRAFFIC CONTROL [BETRIEBLICHE, TECHNISCHE
UND WIRTSCHAFTLICHE ASPEKTE EINES
AERONAUTISCHEN SATELLITENSYSTEMS FUR DIE
ZIVILE FLUGSICHERUNG]**

R. H. G. Martin and O. L. Gneigner Duesseldorf Deut. Ges. fuer
Ortung und Navigation 1969 45 p In GERMAN Presented at
the Intern. Navigation Meeting, Hamburg, 28 - 30 Oct. 1969
Avail: NTIS

The economic and operational problems connected with the introduction of a navigation satellite system are discussed. The questions arising in air traffic control and flight path assignment over the North Atlantic are discussed. It is concluded that subsonic traffic, using inertial navigation, will not necessitate the installation of navigational satellite systems. This will, however, become necessary for supersonic air transport to improve ground-air communications.

ESRO

N71-12601# Advisory Group for Aerospace Research and Development, Paris (France).

**THE APPLICATION OF DIGITAL COMPUTERS TO
GUIDANCE AND CONTROL**

G. Alan Whitfield, ed. Nov. 1970 277 p refs Presented at
10th Meeting of the Guidance and Control Panel of AGARD,
London, 2 - 4 Jun. 1970

(AGARD-CP-68-70) Avail: NTIS

The use of integrated circuits and medium size integrated devices in designing digital computers for aerospace vehicles is considered. The manner in which digital computers are being or can be used to improve the navigation and control of aerospace vehicles and the design of the computers themselves are emphasized.

N71-12604# Teldix Luftfahrt-Ausruestungs G.m.b.H., Heidelberg
(West Germany).

**SYSTEMS TASKS FOR THE DATA PROCESSING
EQUIPMENT OF ADVANCED AIRCRAFT NAVIGATION
SYSTEMS**

F. G. Unger and R. S. Sindlinger In AGARD The Appl. of Digital
Computers to Guidance and Control Nov. 1970 15 p

Avail: NTIS

The tasks of the data processing equipment in advanced navigation systems for aircraft are vastly increased as compared

to conventional systems in use today. Major tasks are processing of different sensor information, solution of navigation equations, optimal use of redundant data by filtering and estimation, automatic mode control, and malfunction detection and isolation. These tasks are described in detail and possible hardware solutions are discussed.

Author

N71-12608# Elliott Flight Automation, Ltd., Rochester (England).
Airport Works.

**THE CASE FOR SPECIALISED SYSTEM PROCESSORS IN
AIRBORNE INSTALLATIONS**

P. A. Hearne In AGARD The Appl. of Digital Computers to
Guidance and Control Nov. 1970 15 p

Avail: NTIS

The favourable changes made possible in avionics systems by the ready availability of low-cost, single or limited task processors are examined. The system requirements of airborne data processors in the areas of navigation, weapon delivery, flight control, engine control, air data and displays are also considered. From this examination, three different generic types of processor are derived. One of these generic types, a small control processor, is examined in detail and the various analyses and tradeoff studies carried out to determine its structure are summarized. The hardware implementation of this machine is then discussed. Finally, a comparison between a 'distributed computer' avionics system using a number of these machines on a large, centralized multiprocessor system is made. From this comparison, it is shown that the distributed system has a number of important advantages and is a more flexible and cost-effective solution for avionics systems.

Author

N71-12609# Ferranti, Ltd., Edinburgh (Scotland). Inertial Systems
Dept.

**ECONOMIES OF INTERFACING WITH SMALL SENSOR
COMPUTERS**

K. R. Brown In AGARD The Appl. of Digital Computers to
Guidance and Control Nov. 1970 10 p

Avail: NTIS

The newer generation of digital processors indicates that the interface between computer and sensor is the major part of the complete system. This is particularly true in the aircraft navigation field where the trend is toward self-contained systems which include a small digital processor, the sensor computer. To make such self-contained systems economical, it is necessary to restrict the size and cost of the interface coupling the computer to the sensors and to the remaining systems. Certain techniques which reduce the cost of storage within the interface and permit the sharing of expensive high accuracy parts of the circuitry are described. Certain basic design principles and rules are stated, and the use of these rules is illustrated by two examples: the interface with an inertial platform and a synchro/resolver interface unit.

Author

N71-12610*# National Aeronautics and Space Administration.
Flight Research Center, Edwards, Calif.

**FLIGHT RESEARCH EXPERIENCE WITH GUIDANCE AND
CONTROL COMPUTERS RELATED TO GENERAL
APPLICATIONS**

Melvin E. Burke In AGARD The Appl. of Digital Computers to
Guidance and Control Nov. 1970 12 p refs

(NASA-TM-X-66491) Avail: NTIS CSCL 17G

Several guidance and control research programs involving the X-15 and F-104 airplanes are discussed, with the discussion oriented toward airborne digital computer utilization. An analog and a digital systems mechanization are compared, and the performance advantages of the digital system are pointed out. The flexibility of the digital computer as a research tool is indicated, as are advantages of decentralized computers. Application of a general purpose computer to the solution of strapdown system equations was

successful in the laboratory in preparation for a flight program. The effects of input-output mechanizations on software complexity are discussed. The utility of a general purpose digital computer is shown by its flexibility in being used for various research tasks. This utility is degraded, however, by the effort required to write programs in machine language for real-time applications. Author

N71-12611# Royal Aircraft Establishment, Farnborough (England). Avionics Dept.
DIGITAL COMPUTING ASPECTS OF THE JAGUAR NAV/ATTACK SYSTEM
D. E. Humphries /in AGARD The Appl. of Digital Computers to Guidance and Control Nov. 1970 10 p ref

Copyright. Avail: NTIS

The Jaguar navigation/attack system performs approximately the same task as that in the Harrier aircraft, which is wholly analog, but does the job using a digital computer for roughly the same cost. Despite the similarity of Harrier system requirements, every endeavour has been made to prevent the system from becoming a digital copy of analog ideas, but to approach each requirement from a digital viewpoint. The lessons that have been learned and the techniques that have been evolved during its development up to its present stage of aircraft flight trials are described. A brief description of the units which comprise the system and the facilities which it provides is given, with particular emphasis on those areas where the change to a digital computer has allowed much greater design freedom and operational flexibility. Author

N71-12612# Industrienanlagen-Betriebsgesellschaft m.b.H., Ottobrunn (West Germany).
THE EFFECT OF DIGITAL COMPUTER LIMITATIONS AND SENSOR ERRORS ON THE ACCURACY OF AN AUTOMATIC BOMB RELEASE
Gerhard Schroeter /in AGARD The Appl. of Digital Computers to Guidance and Control Nov. 1970 7 p
Avail: NTIS

Onboard computer and attitude/air data sensor errors cause delivery errors of automatically released bombs. For a retarded bomb, it is shown by numerical evaluation that with a uniform distribution of release conditions the computing error is approximately normally distributed with mean value zero and standard deviation sigma, sigma being dependent on the degree of the polynomial and the width of the admissible interval of release conditions. Formulas are also derived for estimating the influence of the inaccuracy of weapon computer input data on the impact point. These formulas can be applied to derive the requirements which attitude/air data sensors should satisfy to provide for sufficiently accurate bombing. An example is given. Author

N71-12613# Air Force System Command, Wright-Patterson AFB, Ohio. Avionics Lab.
RECENT ADVANCES IN SELF-ORGANIZING AND LEARNING CONTROLLERS FOR AERONAUTICAL SYSTEMS
Cecil W. Gwinn and Roger L. Barron (Adaptronics, Inc., McLean, Va.) /in AGARD The Appl. of Digital Computers to Guidance and Control Nov. 1970 15 p refs
Avail: NTIS

The development of various types of learning and self organizing machines is discussed, with emphasis on a probability state variable machine. A self-organizing controller based on the probability state variable machine is investigated, including some results of flight testing of an elementary version of the controller and certain aspects of the design for a self organizing control system for on line optimization of thrust specific fuel consumption in turbopropulsion systems. R.B.

N71-12614# Smiths Industries, Ltd., Cheltenham (England). Aviation Div.

HIGH INTEGRITY DIGITAL FLIGHT CONTROL

J. F. Meredith and K. A. Helps /in AGARD The Appl. of Digital Computers to Guidance and Control Nov. 1970 7 p

Avail: NTIS

The development of high integrity digital flight control is discussed with respect to the variation in performance of nominally identical pieces of equipment. In a multiplex system each analog subchannel has a certain design transfer function which is approximately achieved in practice by the use of one or more amplifiers of finite gain together with various smoothing and stabilizing filters. Discrepancies between subchannels arise because of the legitimate variation of component values within their tolerance band. The discrepancies in transfer function may affect the signals which are being processed in a way which is indistinguishable from certain fault conditions. As a result, the level of the threshold of signal discrepancy above which the system detects a fault must be made higher than the level which may legitimately be caused by component value variations. The use of high integrity digital flight control is considered as a way to overcome such problems. Author

N71-12615# Advisory Group for Aerospace Research and Development, Paris (France).

REALIZATION OF NONLINEAR CONTROL METHODS WITH DIGITAL CONTROL UNITS

W. Sobotta and H. J. Berger /in AGARD The Appl. of Digital Computers to Guidance and Control Nov. 1970 16 p

Avail: NTIS

Some characteristic disadvantages of linear control methods used in conventional control units for attitude stabilization of VTOL aircraft are discussed. A special nonlinear stability augmentation system was tested on the flying bedstead SG 1262 of VFW, Bremen, in order to obtain information on the improvement of handling qualities in VTOL aircraft. The tests show that it is advantageous when the response time is about proportional to the pilot commands. A digital control unit was developed, which, at given sampling time and given maximum control power, yields a response time proportional to the command. The control algorithms were combined in such a manner that both the commands and the disturbances are optimized. The control units are distinguished by a relatively simple setup with few digital computer elements. Author

N71-12616# Elliott Flight Automation, Ltd., Rochester (England). Airport Works.
DIGITAL DATA PROCESSING IN AUTOMATIC FLIGHT CONTROL SYSTEMS

R. W. Howard /in AGARD The Appl. of Digital Computers to Guidance and Control Nov. 1970 15 p

Avail: NTIS

Digital data processing is examined as another technique for the designer of automatic flight control systems. It is discussed in relation to three general aspects of all AFCS, those of inner loop, outer loop and executive functions. Various types of modern aircraft system are compared in assessing the impact of digital techniques and it is concluded that although it is not cost effective for all computing requirements at present, it will progressively replace analog flight control computing in the future. A warning is given against adopting central computing techniques as a means of speeding this process. Author

N71-12674# National Physical Lab., Teddington (England). Aerodynamics Div.

TEST CASES FOR NUMERICAL METHODS IN

TWO-DIMENSIONAL TRANSONIC FLOWS

R. C. Lock, comp. Paris AGARD Nov. 1970 25 p refs
(AGARD-R-575-70) Avail: NTIS

In order to provide test cases for the development of numerical methods for the computation of two-dimensional transonic flows round airfoils, six airfoil shapes were selected for which accurate solutions are available. These include both symmetrical and cambered profiles, non-lifting and lifting, in subcritical and supercritical (shock-free) flow.

Author

N71-12680# Weather Squadron (24th), Detachment 10, Randolph AFB, Tex.

TERMINAL FORECAST REFERENCE FILE, RANDOLPH AIR FORCE BASE, TEXAS Final Report

Sep. 1970 61 p

(AD-712681) Avail: NTIS CSCL 4/2

The reference file discusses factors affecting the weather at Randolph AFB, TX. Included are location and topography, weather controls, climatic aids, local forecast study, special synoptic studies, and rules of thumb.

Author (TAB)

N71-12728*# Bowles Fluidics Corp., Silver Spring, Md.
FLUIDIC WIND SENSOR RESEARCH LEADING TO A FLIGHT TEST MODEL Final Report

V. F. Neradka Dec. 1970 64 p refs

(Contract NAS12-2257)

(NASA-CR-111808; R-11-13-70) Avail: NTIS CSCL 14B

Three tasks leading to the delivery of a flyable fluidic low speed wind sensor are discussed. These include a flow visualization study of the flow internal and external to the sensor with regard to velocity threshold and angular resolving capability. Based on the research, a flight-worthy model of a single axis sensor was fabricated and wind tunnel tested over the velocity range $-160 < V < 160$ ft/sec. Of particular interest is the linearity of the sensor for $V < 20$ ft/sec. Wind tunnel tests in a contaminated atmosphere were conducted and the unit continued to operate after several days in severe environments. A configuration for a model which measures air speed and direction over total spherical coordinates is presented.

Author

N71-12736*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

LUNAR FLYING PLATFORM SIMULATOR

David F. Thomas, Jr. and Paul R. Hill Washington Dec. 1970 21 p refs

(NASA-TN-D-6001; L-6829) Avail: NTIS CSCL 14B

The construction and operation of a body-motion-controlled five-degree-of-freedom simulation of a jet-supported lunar flying platform is described. Results from a number of short investigations performed with this simulator are presented. In addition, a comparison is made of the equations of motion of a flying platform and this device; this comparison indicates that this device may be used to provide, in earth gravity, a reasonably accurate five-degree-of-freedom simulation of a jet-supported lunar flying platform.

Author

N71-12756# European Space Research Organization, Paris (France). Directorate of Programmes and Planning.

AERONAUTICAL SATELLITES

D. Lennertz Jun. 1970 23 p refs

(ESRO-SP-61) Avail: NTIS

After a brief description of the historical background of aeronautical satellites, the present and future nonsatellite means of

air traffic control and their limitations are discussed. The services, the economic and technical aspects of an aeronautical satellite system are considered, resulting in the call for carrying out the envisaged ESRO/NASA aeronautical satellite program, which is also briefly described.

Author (ESRO)

N71-12760# TRW Systems, Redondo Beach, Calif.

SUPPORTING STUDIES FOR HSGT SYSTEM REPORTS Final Report

Jun. 1970 522 p refs

(Contract DOT-353-66)

(PB-193144; TRW-06816-6041-R0-00) Avail: NTIS CSCL 13F

The development and characteristics of high speed ground transportation systems are discussed. Appendices covering various detailed analyses on a high speed rail system, tracked air cushion vehicle systems, multimodal systems, and automated highway systems are presented.

Author

N71-12776*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

HOLOGRAPHIC INSTRUMENTATION APPLICATIONS

Boris Ragent and Richard M. Brown, eds. Washington 1970 249 p refs Conf. held at Moffett Field, Calif., 13-14 Jan. 1970

(NASA-SP-248) Avail: NTIS CSCL 14E

Selected papers are presented on application of holographic instrumentation to nondestructive testing, optical memory and data processing, measurement of small linear and angular displacements, study of fluid heat transfer phenomena, and wind tunnel flow visualization.

N71-12795*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

A HOLOGRAPHIC FLOW VISUALIZATION SYSTEM

Richard M. Brown *In its* Holographic Instrumentation Appl. 1970 p 213-219 refs

Avail: NTIS CSCL 14E

There have been many attempts to apply holographic interferometry to the examination of fluid flow fields. To investigate the application of holography to airflow studies, a system is considered that can be used to make holograms in an extremely noisy wind tunnel environment. Details and features of the system are examined; for example, the advantages and disadvantages of diffusers are discussed. A variable ratio beamsplitter that makes efficient use of the laser light is described.

Author

N71-12939*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PERFORMANCE OF NOISE SUPPRESSORS FOR A FULL-SCALE FAN FOR TURBOFAN ENGINES

Edward J. Rice [1970] 13 p refs Presented at the 9th Aerospace Sci. Meeting, New York, 25-27 Jan. 1971; Sponsored by AIAA

(NASA-TM-X-52941) Avail: NTIS CSCL 21E

Performance tests of inlet and exhaust noise suppressors for a six foot diameter fan for a high by-pass ratio turbofan engine are discussed. The perforated plate on honeycomb suppressors provided a much broader band noise attenuation than was predicted. The theory used for the design of the suppressors is discussed. The theory predicts the frequency for peak attenuation but underpredicts the peak attenuation amplitude. For frequencies above and below peak, the observed attenuations are more than predicted. Degradations of the aerodynamic performance due to the noise suppressors were smaller than the experimental errors which were estimated to be two percent.

Author

N71-12985# Institut Franco-Allemand de Recherches, St. Louis (France).

STUDY OF SOME METHODS OF ANALYSIS OF HOLOGRAMS OF PHASE OBJECTS, PRINCIPALLY FOR THE PURPOSE OF APPLICATIONS TO HYPERSONIC AERODYNAMICS IN THE FREE-FLIGHT TUNNEL [ETUDE DE QUELQUES METHODES D'ANALYSE DES HOLOGRAMMES D'OBJETS DE PHASE, PRINCIPALEMENT DANS LE BUT D'APPLICATIONS A L'AERODYNAMIQUE HYPERSONIQUE EN TUNNEL DE TIR]

P. Smigielski 15 Dec. 1969 57 p refs In FRENCH (ISL-T-49/69) Avail: NTIS

The reflected wave hologram of a gaseous flow is analyzed by polarized light differential interferometry as well as by Schlieren method with defocused phase filter. Application of both methods to the same hologram for measuring shifts of one or more strips makes it possible to determine the optical path differences between two neighboring light beams in the object, or the mass value equivalent to the optical path gradient. Strip orientation and adjustment of the focussing error determines the sensitivity. Results from a single hologram establish the advantages of this method in aerial flight systems; a white light visible holographic interferogram is obtained by using a Wollaston-prisma in the object beam and the reference beam as analyzer. Intensity distribution evaluations of pictures obtained by Schlieren technique with phase plates of different forms indicate that pictures from two semiplanes with phase shifts can be equivalent. The advantage of plates situated outside the focal point, as used in short time photography, constitute avoidance of possible damage by the ruby laser beams.

Transl. by G.G.

N71-12997# Air Weather Service, Scott AFB, Ill.
AIR WEATHER SERVICE WEATHER-MODIFICATION PROGRAM (FY 1970) Annual Survey Report

Herbert S. Appleman, Everett D. Figgins, and Laurence D. Mendenhall Aug. 1970 18 p
(AD-712392; AWS-TR-236; AR-3) Avail: NTIS CSCL 4/2

The report describes briefly the weather-modification (fog dissipation) projects undertaken by the Air Weather Service during FY 1970. The techniques employed, equipment used, and the project results are covered. This report is not intended to provide the technical details important to the weather-modification specialist but only to inform the AWS community of the current capabilities AWS possesses in weather modification.

Author (TAB)

N71-13023*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

INTEGRATING-MATRIX METHOD FOR DETERMINING THE NATURAL VIBRATION CHARACTERISTICS OF PROPELLER BLADES

William F. Hunter (M.S. Thesis—Va. Polytech. Inst.) Washington Dec. 1970 73 p refs
(NASA-TN-D-6064; L-5539) Avail: NTIS CSCL 20K

A numerical method is presented for determining the natural lateral vibration characteristics of a rotating twisted propeller blade having a nonuniform, unsymmetrical cross section and cantilever boundary conditions. Two coupled fourth-order differential equations of motion are derived which cantilever the motion of such a beam having displacements in two directions. A development of the integrating matrix, which is the basis of the method of solution, is given. By expressing the equations of motion in matrix notation, utilizing the integrating matrix as an operator, and applying the boundary conditions, the differential equations are integrated and formulated into a eigenvalue problem whose solutions may be determined by various methods. Numerical examples are presented and the computed results are compared with experimental data and exact solutions.

Author

N71-13024*# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

INVESTIGATION OF A MIXED-COMPRESSION AXISYMMETRIC INLET SYSTEM AT MACH NUMBERS 0.6 TO 3.5

Donald B. Smeltzer and Norman E. Sorenson Washington Nov. 1970 245 p refs
(NASA-TN-D-6078; A-3516) Avail: NTIS CSCL 21A

A 20-inch (50.8 cm) capture diameter model of a mixed-compression axisymmetric inlet system was tested. The design Mach number was 3.5 and off-design performance was obtained by translation of the cowl. The inlet system was 1.4 capture diameters long, measured from the cowl to the engine face. Vortex generators were installed just downstream of the throat to reduce the total pressure distortion at the engine face. A boundary-layer removal system was provided on both the cowl and centerbody surfaces of the subsonic and supersonic diffuser. An engine airflow bypass system was located on the cowl surface just upstream of the engine face. The major performance parameters of bleed mass-flow ratio, total-pressure recovery, and total-pressure distortion were determined as a function of bypass mass-flow ratio. Other results obtained were transonic additive drag, inlet tolerance to change in angle of attack, boundary-layer profiles, and surface-pressure distributions. At Mach number 3.5 and zero bypass, total-pressure recovery ranged from 84.5 to 89.5 percent at the engine face with a bleed mass-flow ratio of 14 to 21 percent. The total-pressure distortion level was about 5 percent.

Author

N71-13060# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.

PREDICTED AND MEASURED PRESSURE DISTRIBUTIONS ON TWO AIRFOILS AT MACH NO. 1 Annual Report

Frederick O. Smetana and Donald P. Knepper 1970 32 p
(Grant DA-ARO(D)-31-124-70-G95)
(AD-712397; AROD-8130.1-E) Avail: NTIS CSCL 20/4

The report describes the initial efforts of a study to provide fundamental understanding of transonic flow. It contains a partial description of apparatus and models used for the study including a continuous flow transonic wind tunnel and a comparison of the experimental results with the available viscous transonic theory on two experimental airfoils. The report also contains a discussion of future work.

Author (TAB)

N71-13070# Army Mobility Equipment Research and Development Center, Fort Belvoir, Va. Fuels Handling Equipment Div.

EFFECTS OF CORROSION INHIBITORS ON THE WATER COALESCING CHARACTERISTICS OF MILITARY STANDARD FILTER/COALESCER ELEMENTS Interim Report

Shirley R. Boulware Sep. 1970 19 p
(AD-712999; USAMERDC-1986) Avail: NTIS CSCL 21/4

The report covers a study of the effects of seven corrosion inhibitors on the coalescing characteristics of the DOD-type filter/coalescer elements used to decontaminate liquid hydrocarbon fuels. These corrosion inhibitors are specified for use in military jet fuels, Specification MIL-I-25017, Inhibitors, Corrosion, Fuel Soluble. The report concludes that: The corrosion inhibitors did not produce any adverse effects on the ability of military standard filter/coalescer elements to remove 1-percent water from JP-5 fuel that had been treated with fullers earth; The free-water content of the fuel passed through the filter/coalescer elements during the 1-percent water injection tests ranged from 0 to 2.0 parts per million (ppm) which is within specification limits; The WSIMs of the inhibited JP-5 fuel during the tests were between 16 and 70. The low, free-water content did not correlate directly with the relatively low WSIMs; and The WSIM cannot be used solely to determine the ability of a military standard filter/coalescer element to decontaminate inhibited JP-5 after it has been treated with fullers earth. However, the WSIM does give an indication of the ability of a filter/coalescer element to decontaminate uninhibited JP-5.

Author (TAB)

N71-13080* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COUPLED SUPERSONIC INLET-ENGINE CONTROL USING OVERBOARD BYPASS DOORS AND ENGINE SPEED TO CONTROL NORMAL SHOCK POSITION

Gary L. Cole, George H. Neiner, and Robert E. Wallhagen
Washington Dec. 1970 36 p refs

(NASA-TN-D-6019; E-5499) Avail: NTIS CSCL 21A

An inlet normal shock control was investigated which used the inlet's high response bypass doors as the primary manipulated variable and engine speed as a slow-acting reset control. One advantage of this control concept over separate inlet and engine controls is that it allows the inlet's overboard bypass system to be operated at the most efficient position. Another advantage is that this control can correct for shock displacements in the aft direction when the bypass doors are initially closed, which is not accomplished by a separate inlet control. Experimental results show that the control operates satisfactorily, returning the inlet quickly to design conditions, when subjected to disturbances in diffuser exit corrected airflow. Author

N71-13082# National Research Council of Canada, Ottawa (Ontario). Div. of Mechanical Engineering.

OBSERVATIONS OF TUNNEL FLOW SEPARATION INDUCED BY AN IMPINGING JET

R. A. Tyler and R. G. Williamson Apr. 1970 22 p refs
(NRC-11617; LR-537) Avail: NTIS

Single jets were directed towards, and perpendicular to, the boundary of the 10-ft x 20-ft test section of the NRC V/STOL Propulsion Tunnel. The position of tunnel flow separation, arising from jet impingement and forward penetration, was determined from wool tuft observations for various conditions of jet geometry, jet velocity, and tunnel speed, relevant to V/STOL models involving discrete jets. The results indicated the separation position to be a simple function of the product of effective mainstream/jet velocity ratio and nozzle height/diameter ratio. A value of this product greater than 1.5 was found to be necessary to ensure tunnel flow separation downstream of the jet nozzle. An approximate extension to inclined jets, based on limited test data, is included. Author

N71-13083# Tokyo Univ. (Japan). Inst. of Space and Aeronautical Science.

DETAILED MEASUREMENTS IN THE TRANSITION REGION OF A TWO-DIMENSIONAL WAKE, VOLUME 453, NO. 11

Hiroshi Sato and Yoshio Onda Aug. 1970 60 p refs
(ISAS-453-Vol-35-No-11) Avail: NTIS

Detailed measurements were made on the laminar-turbulent transition of a two-dimensional wake with three kinds of imposed disturbances: the natural disturbance in a wind tunnel, a sound of single frequency, and a sound of two frequencies from outside. In all cases, the transition to turbulence is gradual. When a sound of single frequency is introduced into the wake, the induced velocity fluctuation is regular and periodic and it persists, resulting in a transition delay. When a sound of two frequencies $f_{sub 1}$ and $f_{sub 2}$ is introduced, two velocity fluctuations are induced. They grow independently while amplitudes are small. When amplitudes exceed certain values, two fluctuations interact and both amplitudes are reduced. The behavior of a slow, irregular fluctuation found in the natural transition resembles that of $f_{sub 1}$ - $f_{sub 2}$ component in many respects. Both fluctuations must be generated by the same process. The amplification of randomness in the transition process may be accomplished by the mutual suppression of amplitudes and by the generation of low-frequency components from high-frequency components. Author

N71-13126# Advisory Group for Aerospace Research and Development, Paris (France).

SYMPOSIUM ON STRUCTURAL OPTIMIZATION

Oct. 1970 397 p refs Conf. held at Istanbul, 8-10 Oct. 1969
(AGARD-CP-36-70) Avail: NTIS

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N71-13131# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.

OPTIMIZATION UNDER AEROELASTIC CONSTRAINTS

Warren H. Weatherill (Boeing Co., Seattle), Holt Ashley, and S. C. Mc Intosh, Jr. In AGARD Symp. on Structural Optimization Oct. 1970 30 p refs

Avail: NTIS

Limitations are placed on some dynamic or aeroelastic eigenvalue of an aeronautical structure of prescribed shape, topology

and overall dimensions. It is then attempted to minimize the rigidity-determining mass or some other related figure of merit. A fairly comprehensive literature survey is included. The cases analyzed to date have fallen into two rather idealized categories. With few exceptions, these examples have involved a single constraint, such as fixed fundamental frequency of vibration, speed of torsional divergence or speed of flutter. On the one hand, situations have been treated involving a one-dimensional structure (bar, beam, rod) governed by a simple ordinary differential equation. On the other, finite-element or modal idealizations of more elaborate configurations have led to optimal solutions on nonlinear algebraic or transcendental systems. Both approaches are capable of generalization, e.g., by the addition of other simultaneous constraints. But the finite-element approach shows greater promise for practical applications.

Author

N71-13132# British Aircraft Corp., Preston (England).

AUTOMATED ANALYSIS AND EFFICIENT DESIGN OF REAL STRUCTURES

I. C. Taig /in AGARD Symp. on Structural Optimization Oct. 1970 25 p refs

Avail: NTIS

The development of computer facilities to aid the efficient design of aircraft structures is considered. Practical aspects of an automated design system not normally covered in analytical treatments of the subject are discussed. Particular attention is given to the need to make vital decisions early in the design period, to the kind of information which will contribute to sound decisions and to the most profitable developments in computing facilities to meet these needs. Described is a particular system for automated analysis and design which aims to meet these requirements by progressive improvement of procedures already in use in a design office. The main developments are an engineering communication language, its application to problem specification and optimum structural design and the integration of analysis and design by automated idealisation. In a brief review of the present level of development and application to design it is concluded that the most urgent improvements needed are the full integration of the system, the addition of graphic input facilities and the study of the criteria used to assess structure merit.

Author

N71-13134# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

PRACTICAL APPLICATION OF FINITE ELEMENT METHODS IN THE DESIGN OF STRUCTURES

M. Fleming /in AGARD Symp. on Structural Optimization Oct. 1970 27 p refs

Avail: NTIS

A comparison between test- and theoretical results using the finite element method is given and the numerical stability of this method is considered. Results of static and dynamic calculations are shown. Structural problems which occurred in the VTOL-technique and their solution with the displacement method are explained.

Author

N71-13135# Bell Aerosystems Co., Buffalo, N. Y. Structural Systems Dept.

THE ROLE OF OPTIMIZATION IN THE DESIGN OF AIRCRAFT STRUCTURES

Ronald A. Gellatly /in AGARD Symp. on Structural Optimization Oct. 1970 18 p refs

Avail: NTIS

The long term goal in structural research is the development of integrated design procedures whereby the engineer-analyst and the computer perform complementary interactive roles in the total design process. As a first major step toward this goal the methodology of structural optimization has been evolved. Although

developed principally to perform the automatic design of optimum structures, these procedures have been extended into all aspects of preliminary structural design. With these computational tools, the designer is now enabled to make analytically based quantitative and qualitative judgments on the relative merits of various candidate configurations necessary to satisfy overall performance requirements. Parametric studies of the influence of major structural characteristics on total system performance can be carried out rapidly using ideal optimized structures as bases of comparison. In the subsequent design of the selected configuration, the same principles of optimization can be utilized by the designer to achieve the optimum distribution of structural material at primary and detail design levels.

Author

N71-13137# Air Force Systems Command, Wright-Patterson AFB, Ohio. Flight Dynamics Lab.

STRUCTURAL OPTIMIZATION OF A SUPERSONIC HORIZONTAL STABILIZER

J. R. Johnson and D. S. Warren /in AGARD Symp. on Structural Optimization Oct. 1970 19 p refs Prepared in cooperation with Douglas Aircraft Co., Inc., Santa Monica, Calif.

Avail: NTIS

An existing computer program for structural optimization by gradient search techniques was modified to include an approximate constraint for flutter. The modified program was used to design a horizontal stabilizer for a supersonic aircraft. The idea of the flutter constraint was generalized to provide a family of criteria to account for flutter, divergence, and elastic stability in structural optimization. The criteria are function of displacements and therefore can be easily implemented, are economical to apply, and allow simultaneous optimization for strength and aeroelastic criteria. The stabilizer was first designed for strength using a fully stressed design criteria. The stabilizer was then redesigned with active strength and flutter constraints using the steepest descent and side step modes of the program. The results show a ten percent increase in weight to accommodate the flutter constraint, and local stiffening of the structure to increase the torsional frequency.

Author

N71-13141# Rolls-Royce, Ltd., Derby (England). Aero Engine Div.

DESIGNING DISC PROFILES FOR A GAS TURBINE ENGINE USING AN INTERACTIVE GRAPHIC DISPLAY DEVICE

M. A. Bayfield and R. D. McKenzie /in AGARD Symp. on Structural Optimization Oct. 1970 13 p refs

Avail: NTIS

Described is the early use of a program which an aero engine designer may use to draw a two-dimensional mesh pattern over the profile shape of a rotating disc. The program allows the designer to construct this mesh on the screen of a graphics terminal, at which he may modify the design of both the mesh and the original disc profile. When he is entirely satisfied with each of these he is able to transfer all relevant information about the mesh, together with data describing nodal loads, displacements, pressures and stalling properties to a computer file. A batch program that can be run at a later time will read this filed data and with it carry out a stress analysis of the disc using finite element techniques. Experience has shown that this method of entering data to the computer is very easy to use but, most important, design times can be reduced.

Author

N71-13143# Lockheed-California Co., Burbank.

THE OPTIMUM DESIGN OF SHELL STRUCTURE FOR STATIC STRENGTH, STIFFNESS, FATIGUE AND DAMAGE TOLERANCE STRENGTHS

Walter J. Crichlow /in AGARD Symp. on Structural Optimization

Oct. 1970 32 p refs

Avail: NTIS

Modern airframe structural design now involves accountability for: (1) static strength and stiffness of undamaged structure; (2) time to initiate fatigue cracks or the fatigue life of undamaged structure; (3) fracture toughness or residual static strength of damage structure; and (4) rate of crack propagation or the fatigue life of the damaged structure. The imposition of fatigue, fracture mechanics, and rate of crack propagation as new material characteristics, all highly sensitive to many environmental factors has extended the materials engineer's task of providing optimized materials and processing treatments and the structures engineer's task of designing for these phenomena. A systems approach to the design of airframe structure is described utilizing all of these material characteristics to achieve the level of structural integrity demanded of modern aircraft. Author

N71-13194# Naval Air Engineering Center, Philadelphia, Pa. Engineering Dept.

COMPARATIVE STUDY OF PROPOSED SIGNAL ACQUISITION METHODS FOR PLAT CROSSHAIR STABILIZATION

David R. Flanders 15 Sep. 1970 103 p

(AD-712511; NAEC-ENG-7669) Avail: NTIS CSCL 17/7

The report presents a comparative study of two proposed stabilization systems in an attempt to determine the most reliable interim measure providing a stabilization signal to the PLAT (Pilot - L.S.O. Landing Aid Television) mirror. In addition, a brief summary of the work presently accomplished in the area of PLAT stabilization is undertaken. Author (TAB)

N71-13236# Von Karman Inst. for Fluid Dynamics, Rhode Saint-Genese (Belgium).

FLAT PLATE PRESSURE DISTRIBUTION AND HEAT TRANSFER IN A CONICAL HYPERSONIC FLOW

F. R. Bailey Jun. 1969 59 p refs

(VKI-TN-56) Avail: NTIS

A theory is presented for predicting the weak pressure interaction and heat transfer distribution on a flat plate with a laminar boundary layer in a conical hypersonic flow. Good agreement was obtained with measurements made in a longshot free-piston hypersonic wind tunnel using a nominal Mach number 15 conical nozzle of 6 deg half-angle. It was found that the surface pressure predicted using the present theory agreed better with experiment than the Lees and Probstein method using the local values of viscous interaction parameter x . This indicates that the effect of pressure gradient on the rate of boundary layer growth must be accounted for in hypersonic conical flows. The present theory was also used to study the effects of nitrogen condensation on flat plate surface pressure and heat transfer. The onset of nitrogen condensation in the longshot was found to occur under conditions similar to those found in other intermittent facilities. Author (ESRO)

N71-13237# Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.

WIND TUNNELS AND TEST RIGS OF THE DEPARTMENT OF AERONAUTICS, IMPERIAL COLLEGE

P. Bradshaw Apr. 1970 6 p

(IC-AERO-REPT-70-01) Avail: NTIS

Details and dimensions of 14 test rigs used for teaching and research, ranging from a water channel to a Mach 25 nitrogen tunnel, are tabulated. Author (ESRO)

N71-13281# Technische Hochschule Stuttgart (West Germany). Inst. fuer Mechanik.

BEHAVIOR OF A GYROCOMPASS AND A GYRO HORIZON

WHILST LOOPING [VERHALTEN VON KURSKREISEL UND KREISELHORIZONT BEIM LOOPING]

Joerg-Ulrich Steinwand (Ph.D. Thesis) 1970 103 p refs In GERMAN

Avail: NTIS

The behavior of attitude gyros with stops on the inner frame is investigated during a looping flight. The stops limit the freedom of rotation of the inner frame to approximately $+$ or $-$ 80 to $+$ or $-$ 85 deg and may be fixed or flexible. It is checked, under which conditions the inner frame is stopped and how hard the flexible stops have to be, to prevent blocking the frame. A precession takes place due to a moment working on the gyro as the inner frame is on one of its stops. At the end of the looping this results in an indication error, which is investigated. ESRO

N71-13364# National Aerospace Lab., Amsterdam (Netherlands). **ELECTRON FRACTOGRAPHY OF FATIGUE IN A HIGH STRENGTH STEEL**

D. Broek and W. J. van der Vet Mar. 1969 34 p refs

Sponsored by Roy. Neth. Air Force

(NLR-TR-69043-U) Avail: NTIS

An extensive electron fractographical investigation was carried out of a series of fatigue failures in a 4340 type steel. Low tempering temperatures and low stresses promote intergranular fatigue fractures. High stresses and high tempering temperatures promote the formation of striations. Author (ESRO)

N71-13401# Centre National de la Recherche Scientifique, Meudon (France). Lab. d'Aerothermique.

INCIDENCE AND BLUNTNESS EFFECTS ON THE AERODYNAMIC CHARACTERISTICS OF A FLAT PLATE IN A STRONG INTERACTION REGIME [EFFECTS D'INCIDENCE ET D'EMOUSSEMENT SUR LES CARACTERISTIQUES AERODYNAMIQUES D'UNE PLAQUE PLANE EN REGIME DE FORTE INTERACTION]

Jean Allegre and Georges Herpe May 1970 53 p refs In FRENCH; ENGLISH summary Sponsored by Direc. des Rech. et Moyens d'Essais

(Rept-70-4; Publ-372) Avail: NTIS

After discussing incidence and leading edge bluntness effects, wall pressure and heat transfer distributions along flat plates are compared with strong interaction regime theory. Components of aerodynamic forces due to the wall pressure only were compared with total aerodynamic force values to obtain the skin friction effect for various flat plate configurations. Data were obtained in a Mach 8 rarefied hypersonic flow with a free-stream Reynolds number of 2200 per cm; viscous interaction parameters along the plates varied between 4 and 15. Author (ESRO)

N71-13402# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).

PRECISE CALCULATION OF UNSTEADY AERODYNAMIC PRESSURES IN SUBSONIC FLOW [CALCUL PRECIS DES PRESSIONS AERODYNAMIQUES INSTATIONNAIRES EN SUBSONIQUE]

Pierre Salaun 1970 34 p refs In FRENCH; ENGLISH summary

(ONERA-NT-163) Avail: NTIS

The aerodynamic pressures on a rectangular wing vibrating in subsonic flow were calculated by the integral equation method, in which the pressure and the right hand member were developed in limited series of orthogonal polynomials thus replacing the integral equation by a system of linear equations. Aerodynamic coefficient matrices are presented for aspect ratios 1 and 3, Mach numbers 0.5 and 0.7, and reduced frequencies 0.5 and 2.

Author (ESRO)

N71-13403# Centre National de la Recherche Scientifique, Meudon (France). Lab. d'Aerothermique.

EXPERIMENTAL STUDY OF THE WAKES OF CYLINDERS AND SPHERES IN LOW DENSITY HYPERSONIC FLOWS [ETUDE EXPERIMENTALE DU SILLAGE DE CYLINDRES ET DE SPHERES EN ECOULEMENT HYPERSONIQUE DE GAZ RAREFIE]

Henri Coudeville and Michel Raffin Dec. 1969 98 p refs In FRENCH; ENGLISH summary Sponsored in part by DRME (Rept-69-7; Publ-369) Avail: NTIS

Sphere and cylinder wakes were studied in low density supersonic and hypersonic flows. The Knudsen numbers, based on the diameters, ranged from 0.01 to 10 for Mach numbers of 4, 8 and 20. Wake structure was characterized by the bow shock wave intensity and thickness, and also by the existence or absence of a trailing shock wave. Comparison of the wake configurations of cylinders and spheres provided a reference length for accurate definition of the Knudsen number. Author (ESRO)

N71-13404*# Nielsen Engineering and Research, Inc., Mountain View, Calif.

AN EXPLORATORY AERODYNAMIC AND STRUCTURAL INVESTIGATION OF ALL-FLEXIBLE PARAWINGS

J. N. Nielson, S. B. Spangler, S. S. Stahara, and A. L. Lee Washington NASA Dec. 1970 160 p refs (Contract NAS1-8477)

(NASA-CR-1674; NEAR-TR-20) Avail: NTIS CSCL01C

A theoretical investigation was made of the aerodynamic and structural aspects of all-flexible parawings. These wings are characterized by large amounts of spanwise camber. An aerodynamic method was developed through the use of slender-body theory to account for the principal nonplanar effects. The method considers sections in the plane normal to the root chord to be circular arcs which may translate and dilate with distance along the root chord. The method yields spanwise and chordwise distributions of loading, the distribution of suction along the leading edge and the induced drag. Various static equilibrium models were examined for the purpose of determining the canopy tension distribution and rigging line loads. The methods were applied to a single- and a twin-keel parawing for which data on inflated shape, overall aerodynamic loads, and line loads were obtained. Comparisons with these load data were made using the measured canopy shapes. Author

N71-13405*# Princeton Univ., N.J. Dept. of Aerospace and Mechanical Sciences.

AN EXPERIMENTAL INVESTIGATION OF PANEL DIVERGENCE AT SUBSONIC SPEEDS

Thorsteinn Gislason, Jr. Jul. 1970 57 p refs

(Grant NGR-31-001-146)

(NASA-CR-111821; AMS-921) Avail: NTIS CSCL 20D

Panel flutter and panel divergence were investigated as structural aeroelastic problems which lead to fatigue failure. The boundary conditions and thickness of a clamped aluminum panel with a chord to span ratio of 2 in a low Mach number flow regime were studied with the temperature effects, aerodynamic loading and divergence. The conclusions are: (1) A technique has been developed to determine divergence behavior. (2) Post-divergence strain response is essentially as predicted by the linearized potential theory. (3) Divergence occurs at the dynamic pressure that linearized potential theory and a one mode Galerkin solution indicates. (4) Sag and the corresponding curvature of panels greatly increases the post-divergence strain response of thin panels. F.O.S.

N71-13406# National Physical Lab., Teddington (England). Fluid Motion Subcommittee.

THE BEHAVIOUR OF THE LEADING-EDGE VORTICES

OVER A DELTA WING FOLLOWING A SUDDEN CHANGE OF INCIDENCE

N. C. Lambourne, D. W. Bryer, and J. F. M. Maybrey Mar. 1970 57 p refs

(NPL-AERO-1294) Copyright. Avail: NTIS

The transient behavior of leading-edge vortices over a delta wing subject to a sudden change of incidence is studied to understand the wing loadings that can occur in unsteady conditions of flight. In the experiments reported, changes of incidence have been imposed on delta-shaped plates by application of a constant-velocity plunging motion for a limited time; other related unsteady motions are also discussed. Results indicate that after the start of the plunge an effectively steady vortex system established over the plate in a time approximately equal to that required for one chord length of relative forward travel. Where comparisons can be made, Dore's theoretical calculations of the manner in which the vortices move show fair agreement with the experiment. Effects of the transient movements of the vortices on lift distribution are discussed and the inference is drawn that the changes in the distribution of wing loading occurring for an increase of incidence are not simply reversed when the incidence is decreased. Author

N71-13407# Weapons Research Establishment, Salisbury (Australia).

THE USE OF RATE GYROSCOPES IN THE FREE FLIGHT MEASUREMENT OF AERODYNAMIC LATERAL FORCE AND MOMENT COEFFICIENTS

N. E. Gilbert Mar. 1970 38 p refs

(WRE-TN-HSA-164) Avail: NTIS

Suitable flight data regions were selected for the free flight measurement of aerodynamic force and moment coefficients on two bombs, each with four fins. The bombs carried an incidence meter, three rate gyroscopes, and four linear accelerometers. The flight data is fitted to a mathematical model of the force and moment system developed by Maple and Synge. Pitch and yaw rates and pitch and yaw accelerations derived using rate gyroscope measurements are compared with those derived using other sources and the agreement was found to be very good. Static coefficients are found to be equally well obtained using any of the various combinations of rate gyroscope and linear accelerometer measurements. Results are given at a Mach number of 0.6 and very good agreement is obtained between free flight and wind tunnel measurements of the static forces and moments. However, satisfactory free flight measurements of Magnus coefficients and damping coefficient derivatives were not obtained. Because of inadequate instrumentation and uncertainties in rate gyroscope measurement of roll rate, no data were obtained on axial forces and moments. Author

N71-13408# Oxford Univ. (England). Engineering Lab.

EXPERIMENTAL STUDIES OF HYPERSONIC BOUNDARY LAYER TRANSITION

John. E. LaGraff (Ph.D. Thesis) May 1970 281 p refs Sponsored by Min. of Technol.

(Rept-1104/70) Avail: NTIS

The design, instrumentation, and calibration of the Oxford hypersonic gun tunnel and measurements of boundary layer transition on the outside surface of a hollow cylinder model using shadowgraph and surface pitot techniques are described. Transition experiments on the model in various European wind tunnels are compared and a correlation based on nozzle wall boundary layer aerodynamic noise radiation is discussed. Heat transfer measurements on the surface of a 10 deg total angle sharp cone and a flat plate were made and compared with theoretical predictions. Strong flat plate fluctuation intensities, due to large turbulent eddies generated near the model leading edge and initially located in the boundary layer, were found within the boundary layer upstream of the region where transition began. Author (ESRO)

N71-13409# National Physical Lab., Teddington (England).
Aerodynamics Div.

AN INVESTIGATION OF THE EFFECTS OF UNIT REYNOLDS NUMBER AND INCIDENCE ON BOUNDARY-LAYER TRANSITION IN THE NPL 6 INCH BY 6 INCH SUPERSONIC WIND TUNNEL

P. G. Pugh and D. F. Bedder 16 Sep. 1969 24 p refs
(NPL-AERO-1301; ARC-31382) Copyright. Avail: NTIS

Tests made in the NPL 6 in x 6 in tunnel at $M = 3.0$ to determine the effects of unit Reynolds number and incidence on boundary layer transition on a right-circular cone model are reported. The importance of residual steady-state convective heat transfer is highlighted. A simple prediction method is outlined and shown to account for the quantitative effects of incidence.

Author

N71-13410* National Aeronautics and Space Administration.
Langley Research Center, Langley Station, Va.

MINIMUM INDUCED DRAG AIRFOIL BODY Patent

Clarence D. Cone, Jr., inventor (to NASA) Issued 6 Sep. 1966
(Filed 26 Dec. 1962) 8 p Cl. 244-35

(NASA-Case-XLA-00755; US-Patent-3,270,988;

US-Patent-Appl-SN-247423) Avail: US Patent Office CSCL 01A

An electric analog apparatus for measuring the induced drag of a wing form is described for studying means of reducing the induced drag of conventional wings. The analog of the fluid flow pattern is provided by setting up an electric field in a conductive sheet and forming a nonconductive void in the sheet shaped like the wing form. Measurements of potential differences between points on opposite sides of the void are taken. Applications of the electric analog to the analysis of nonplanar wing configurations are given.

N.E.N.

N71-13411* National Aeronautics and Space Administration.
Langley Research Station, Langley Station, Va.

MINIMUM INDUCED DRAG AIRFOIL BODY Patent

Clarence D. Cone, Jr., inventor (to NASA) Issued 10 Mar. 1970
(Filed 30 Sep. 1965) 9 p Cl. 235-61.6; Int. Cl. G06k15/00
Continuation-in-part of US Patent Appl. SN-247423, filed 26 Dec. 1962

(NASA-Case-XLA-05828; US-Patent-3,500,020;

US-Patent-Appl-SN-509460) Avail: US Patent Office CSCL 01A

Additional claims are presented for the electric analog. These claims concern the efficacy of the device in predetermining the specific nonplanar wing configuration having minimum induced drag.

N.E.N.

N71-13412*# National Aeronautics and Space Administration.
Washington, D.C.

RECENT WORKS ON AIRCRAFT-PRIMARY CONTROL AT THE DFL INSTITUTE FOR AIRCRAFT GUIDANCE [NEURE ARBEITEN ZUR FLUGZEUG-PRIMAERSTEUERUNG AM INSTITUT FUER FLUGFUEHRUNG DER DFL]

W. Metzendorf Dec. 1969 20 p Transl. into ENGLISH from German report DFL-8 p 393-404

(NASA-TT-F-12709; DFL-8) Avail: NTIS CSCL 01C

Research was conducted at the DFL Institute for Aircraft Guidance in order to study the characteristics and applicability of digital electrohydraulic systems in flight control.

Author

N71-13413# Southampton Univ. (England). Inst. of Sound and Vibration Research.

THE TRANSMISSION OF SONIC BOOMS SIGNALS INTO

ROOMS THROUGH OPEN WINDOWS. PART 3: EXPERIMENTAL WORK AND GENERAL DISCUSSION

P. G. Vaidya [1970] 2 p refs

Avail: NTIS

Results of some full scale experiments, carried out by using simulated sonic booms, are presented. These results were compared with the predictions obtained previously. A general theoretical description of the buildup of the acoustic field inside a room due to a transient incident onto an open window was developed in detail. Possible extensions of the theoretical analysis are indicated in the Appendix.

Author

N71-13414# National Research Council of Canada, Ottawa (Ontario).

FUELS AND LUBRICANTS SECTION. AIRCRAFT CARBURETOR ICING STUDIES

L. Gardner and G. Moon Jul. 1970 41 p refs

(LR-536) Avail: NTIS

A study was made of the effect of gasoline icing inhibitors on aircraft carburetor icing. An engine test was developed and used to evaluate various types of inhibitor. The results obtained showed that aircraft carburetor icing can be prevented by the inclusion of additives in the gasoline. The use of a teflon-coated throttle plate to prevent ice adhesion was studied and found to virtually eliminate any ice formation on the plate. The use of ethylene glycol monomethyl ether at 0.10 - 0.15% by volume in the gasoline and teflon-coated plate was shown to prevent both carburetor and fuel system icing.

Author

N71-13415# Cranfield Inst. of Technology (England).

AIRCRAFT DESIGN STUDIES: COUNTER INSURGENCY AIRCRAFT WITH SUCTION BOUNDARY LAYER CONTROL

D. Howe Apr. 1970 40 p refs

(Aero-1) Avail: NTIS

A design study of a counter insurgency aircraft with a suction boundary layer controlled wing to give high lift was undertaken. The aircraft has a gross weight of 9800 lb, and was designed to carry a variety of payloads of up to 2000 lb, at a maximum speed of 380 mph. The flight usable lift coefficient of five is achieved at an incidence of approximately 30 deg, which introduces particular layout and undercarriage problems. A twin boom configuration with a variable geometry undercarriage was adopted. It is concluded that the use of a suction boundary layer control system will confer significant performance benefits, but the aircraft might well be handicapped by climatic operational limitations. The variable geometry undercarriage is complex and an alternative layout using a tilt wing is recommended.

Author

N71-13416# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: LEHIGH ACRES DEVELOPMENT, INCORPORATED, MARTIN 404, N40412, ATLANTA, GEORGIA, 30 MAY 1970

30 Sep. 1970 17 p refs Its File No. 3-0757

(NTSB-AAR-70-25) Avail: NTIS

Results from an investigation of the Martin 404, N40412 are given. It was determined that probable cause of the accident was loss of effective engine power due to improper fuel being placed in the tanks. A contributing factor was that the flight crew did not detect the error. It was recommended that a more accurate color coding system for tank fuels be used; refueling nozzles be marked; parts of safety rules 23, 25, 27, and 29 be modified; and existing aircraft be required to be painted within a year after publication of the changes.

E.H.W.

N71-13417# National Transportation Safety Board, Washington, D.C.

AIRCRAFT ACCIDENT REPORT: SEABOARD WORLD AIRLINES, INCORPORATED, DOUGLAS DC-8-63F, N8634, STOCKTON METROPOLITAN AIRPORT, STOCKTON, CALIFORNIA, 16 OCTOBER 1969

30 Sep. 1970 28 p refs /ts File No. 1-0058
(NTSB-AAR-70-24) Avail: NTIS

Results from an investigation of the Douglas DC-8-63F, N8634 crash are given. It was determined that probable cause of the accident was a false ground spoiler position indication during the takeoff portion of a touch-and-go landing that induced the captain to discontinue the takeoff at a point too far down the runway to permit him to stop the aircraft on the runway. It was recommended that the Federal Aviation Administration take the required action to insure that an appropriate warning be included in all DC-8 operations manuals which states that: The ground spoiler selector lever shall be manually positioned to the spoiler extend setting on all rejected takeoffs, regardless of ground spoiler light indications.

Author

N71-13418# Federal Aviation Administration, Washington, D.C. Information and Statistics Div.

MILITARY AIR TRAFFIC ACTIVITY REPORT: CALENDAR YEAR 1969

Viola W. Patterson Jun. 1970 52 p refs
(Rept-70-10) Avail: Issuing Activity

Air traffic activity for calendar year 1969 is reported by U.S. Air Force Bases, Army Airfields, and Naval Aeronautical Facilities in the United States and Overseas. In addition, data on Naval instrument operations, VFR operations, and instrument approaches are presented.

Author

N71-13419# National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.

VALIDATION OF THE GAS GENERATOR METHOD OF CALCULATING JET-ENGINE THRUST AND EVALUATION OF XB-70-1 AIRPLANE ENGINE PERFORMANCE AT GROUND STATIC CONDITIONS

Henry H. Arnaiz and William G. Schweikhard Washington Dec. 1970 45 p refs
(NASA-TN-D-7028; H-596) Avail: NTIS CSCL 01A

Deficiencies in established techniques of measuring aircraft thrust in flight led to the application of the gas generator method of calculating engine thrust to the XB-70-1 airplane. A series of tests on a ground static-thrust stand was performed on the airplane to establish at ground static conditions the accuracy of this method, to measure the installed thrust of the YJ93-GE-3 engine, and to determine the effect of instrumentation errors and nonuniform flows at the engine compressor face on the thrust calculation. Tests with an aerodynamically choked inlet, an opened inlet-bypass system, and varying combinations of operating engines were also conducted. Results showed that the accuracy of the gas generator method was + or - 2 percent for the normal operation of the XB-70-1 airplane at ground static conditions and for the upper 70 percent of the engine's throttle range. They also showed that the effect of individual instrument errors on the thrust calculation was reduced because of the large number of measurements and that abnormally high inlet flow distortion affects the thrust calculation. When corrected for inlet losses, the installed thrust of the YJ93-GE-3 engine agreed favorably with the engine manufacturer's uninstalled estimated thrust for all power settings except those at the low end.

Author

N71-13420# National Aeronautics and Space Administration, Ames Research Center, Moffett Field, Calif.

REINGESTION CHARACTERISTICS AND INLET FLOW

DISTORTION OF V/STOL LIFT-ENGINE FIGHTER CONFIGURATIONS

Jerry V. Kirk and Jerry P. Barrack Washington Dec. 1970 44 p refs

(NASA-TN-D-7014; A-2996) Avail: NTIS CSCL 01A

Reingestion of exhaust gas into engine inlets during hover, and inlet flow distortion with the associated loss in total-pressure recovery during transition were studied using a large-scale generalized lift-engine fighter model powered by J-85 engines. Exhaust gas reingestion during hover was studied on a static test facility, and inlet flow distortion and total-pressure recovery loss were studied in the 40- by 80-foot wind tunnel. Two lift-engine arrangements were studied, the swiveling, retractable and the internally fixed. Both arrangements were subject to excessive thrust loss and compressor stalls due to reingestion when the engine exhaust was vectored nearly vertical. Vectoring the exhaust approximately 20 deg from vertical essentially eliminated reingestion problems. Vectoring the lift-engine exhaust forward and the lift-cruise engine exhaust aft to balance the aircraft and minimize reingestion appears to be a feasible means of allowing VTOL operation. Inlet flow distortion and total-pressure recovery were within acceptable limits for the swiveling, retractable lift-engine configuration. With the inlet guide vane installed to help turn the flow into the engine, the vertically mounted lift engines of the internally fixed configuration with an inlet radius to diameter ratio of 0.19 produced acceptable inlet flow distortion and total-pressure recovery results. Without the guide vane the nominal acceptable distortion level of 10 percent was exceeded at the higher velocity ratios.

Author

N71-13421* National Aeronautics and Space Administration, Flight Research Center, Edwards, Calif.

ENERGY MANAGEMENT SYSTEM FOR GLIDER TYPE VEHICLE Patent

Roger L. Winblade and John P. Smith, inventors (to NASA) Issued 28 Jun. 1966 (Filed 24 Jun. 1962) 14 p Cl. 235-150.22

(NASA-Case-XFR-00756; US-Patent-3,258,582;

US-Patent-Appl-SN-212173) Avail: US Patent Office CSCL 01B

A data processing and display system is described for use as terminal guidance or energy management apparatus on X-15 or DynaSoar vehicles. Real time in-flight total range capability of the vehicle is presented in a graphical display which continuously outlines the possible landing area. The method is based on the empirical fact that the landing area on an assumed flat earth as seen from above is a modified cardioid ahead of the aircraft, with the cardioid valley closest to the aircraft. The area is a function of the vehicle's location, heading, velocity, and altitude, and these data are fed to a special purpose computer. The computer generates voltages applied to an oscilloscope which in turn displays the size and position of the cardioid relative to the map overlay.

N.E.N.

N71-13422* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

MECHANICAL STABILITY AUGMENTATION SYSTEM Patent

John F. Garren, Jr. and James R. Kelley, inventors (to NASA) Issued 20 Oct. 1970 (Filed 24 Feb. 1969) 5 p Cl. 244-76; Int. Cl. B64c13/18

(NASA-Case-XLA-06339; US-Patent-3,534,930;

US-Patent-Appl-SN-801336) Avail: US Patent Office CSCL 01B

A mechanical stabilization system for VTOL aircraft is described. The system includes mechanical means for modifying a pilot's control signal to obtain a desired rate signal. The desired rate signal is compared with the actual rate signal and an error signal is generated. The error signal is then compared with a modified lead signal and used to control a surface actuator. The system has a high level of damping for external disturbances and a low level of damping for pilot maneuver control signals.

N.E.N.

N71-13474* Martin Marietta Corp., Denver, Colo.
PCM TELEMETRY FOR EARTH RESOURCES AIRCRAFT.
END ITEM TEST REPORT, CONTRACT ITEM NO.1

Duane L. Starner Jun. 1969 76 p

(Contract NAS9-8146)

(NASA-CR-108700; MCR-69-286) Avail: NTIS CSCL 09F

Electrical and environmental qualification tests performed on the first PCM production system, and the acceptance testing of other system elements. Author

N71-13576# Advisory Group for Aerospace Research and Development, Paris (France).

BALLISTIC RANGE TECHNOLOGY

Thomas N. Canning, Alvin Seiff, and Carlton S. James, eds. (NASA. Ames Res. Center) Aug. 1970 463 p refs Prepared by NASA. Ames Res. Center and the Defence Res. Estab., Valcartier, Quebec (AGARDograph-138; AGARD-AG-138-70) Avail: NTIS

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N71-13583* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AERODYNAMICS OF BODIES FROM MOTION ANALYSIS

Gary T. Chapman, Donn B. Kirk, and Gerald N. Malcolm /in AGARD Ballistic Range Technol. Aug. 1970 p 267-348 refs

(See N71-13576 04-11)

(NASA-TM-X-66536) Avail: NTIS CSCL 20D

Several techniques for determining the aerodynamic characteristics of bodies in free flight in a ballistic range are examined. Since the measurements from which the aerodynamics are to be deduced usually consist of angular and linear position data from photographic records of a model in flight, discussion is restricted to the analysis of angular and linear position data as functions of either time or distance traveled. Following a discussion of the different coordinate systems used in analyzing free flight data, the differential equations of motion are derived by considering several ways of writing the equations for flight dynamics and combining these with appropriate expressions for the applied forces and moments. The various techniques for deducing drag, static and dynamic stability, lift, and rolling moment coefficients from the measured data are discussed and examples are presented. Also included is a section on error analysis and an appendix treating the method of least squares using differential corrections. A.L.

N71-13610 University of Southern Calif., Los Angeles.

THE FLUTTER OF A TRIANGULAR PANEL

Edward Arthur Wais (Ph.D. Thesis) 1969 233 p

Avail: Univ. Microfilms: HC \$10.60/Microfilm \$3.05 Order No. 70-371

The use and application of the finite element method to general problems in continuum mechanics and particularly to the investigation of the flutter of thin panels is discussed. Panel flutter refers to the unstable oscillations of thin plates, shells, or membranes in a fluid flow caused by the aerodynamic loading. The finite element method, a variation of the Ritz method in the calculus of variations, is used to generate stiffness and mass matrices which respectively represent the elastic and inertia characteristics of the continuum. A slight variation of the finite element method is used to generate an aero matrix which represents the aerodynamic loading in the panel flutter problem. The use of the finite element method allows continua problems to be reformulated as problems of assemblages of discrete elements which are then solved by the use of matrix methods. Dissert. Abstr.

N71-13695* East-West Gateway Coordinating Council, East St. Louis, Ill.

AN ANALYSIS OF AIRPORT TRAVEL DEMANDS, LAMBERT-ST. LOUIS MUNICIPAL AIRPORT

Oct. 1969 78 p Prepared in part by Voorhees (Alan M.) and Assoc., Inc., and Crawford, Bunte, Roden, Inc. (PB-192057) Avail: NTIS CSCL 15E

A study is reported of the impact that 1990 air travel demands will have on vehicular traffic in the St. Louis Bi-State Metropolitan Area. Two surveys were conducted at Lambert-St. Louis Municipal Airport. One evaluated present airline passenger characteristics and the other dealt with the air cargo industry. The survey data provided a base for projecting future airline travel. Author (USGRDR)

N71-13763* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A COMPARISON OF SPHERICAL AND TRIANGULAR BOUNDARY-LAYER TRIPS ON A FLAT PLATE AT SUPERSONIC SPEEDS

Raymond M. Hicks and William R. Harper, Jr. Washington Dec. 1970 39 p refs

(NASA-TM-X-2146; A-3722) Avail: NTIS CSCL 20D

An experimental investigation was conducted in the Ames 1- by 3-foot supersonic wind tunnel using spherical and triangular protuberances to promote artificial boundary layer transition from laminar to turbulent flow on a flat plate. The location of the trips varied from 0.08 in to 1.0 in from the leading edge. The free stream Mach numbers of the test were 1.58, 2.17, and 2.91. At

Mach numbers of 1.58 and 2.17, the spherical trips had a nominal diameter of 0.01 in while the triangular trips had a height of 0.0073 in. At a Mach number of 2.91, 0.015 in (nom.) diameter spheres and 0.0146 in high triangles were used. The relative effect of the spherical and triangular trips was studied by varying unit Reynolds number over a range at each Mach number. The sublimation technique was used exclusively in the investigation to determine the location of transition. Author

N71-13777# Federal Aviation Administration, Washington, D. C. Eastern Region Airport Development Task Force.

AIRPORT DEVELOPMENT TASK FORCE Progress Report

Sep. 1970 59 p

(PR-3) Avail: NTIS

The activities of the Eastern Region Airport Development Task Force are reported. A complete analysis of the demands on the New York metropolitan airport system, the expected growth factors for the area as related to national forecasts, and an appraisal of the capacities of the existing airport facilities, as well as the application of any theoretical improvements to these facilities that could be considered are presented. Specific findings which may be technically feasible to implement, and which are compatible with community need and designed to meet forecast growth are discussed. Author

N71-13800# Boeing Scientific Research Labs., Seattle, Wash. Flight Sciences Lab.

RESULTS OF TRAILING VORTEX STUDIES IN A TOWING TANK

John H. Olsen Sep. 1970 24 p refs

(D1-82-1004) Avail: NTIS

Flow visualization studies were performed in a towing tank using an electrochemically activated dye. Although test Reynolds numbers were far below flight Reynolds numbers (10 to the 4th versus 10 to the 7th power), the results were strikingly similar to flight test data. Two types of instability were observed in the tank. An instability associated with the axial flow within the core was observed to destroy the flow in the neighborhood of the core without destroying the motion far from the core. A second instability involving the mutual interaction of the two vortices was observed but somewhat masked by the first instability. Author

N71-13803# South Alabama Regional Planning Commission, Mobile.

UPPER GULF COAST REGIONAL AIR TRANSPORTATION STUDY, VOLUME 1

Apr. 1970 186 p refs Prepared in cooperation with Speas (R. Dixon) Associates, Inc., Atlanta

(PB-194339) Avail: NTIS CSCL01B

Existing facilities inventory and analysis, capacity analyses of existing facilities, airspace and air traffic inventory and analysis, and forecasts of air carrier and general aviation activity in five year increments through the year 1995 are presented. Also included in the report are results of an air carrier passenger local trip origin survey. Author (USGRDR)

N71-13804# South Alabama Regional Planning Commission, Mobile.

UPPER GULF COAST REGIONAL AIR TRANSPORTATION STUDY, VOLUME 2

Jul. 1970 230 p Prepared in cooperation with Speas (R. Dixon) Associates, Inc., Atlanta

(PB-194340) Avail: NTIS CSCL01B

Air transportation system-wide alternatives available and the major areas of airspace conflict are identified. The recommended plan provides for the overall system of airports as well as identifying the role of each airport in the overall system. New airports are recommended as reliever airports and to serve areas now remote from air service. The critical aircraft and airport development necessary to provide sufficient capacity for the expanded demand along with general funding requirements are indicated for each airport through 1995. Author (USGRDR)

N71-13826# Advisory Group for Aerospace Research and Development, Paris (France).

DATA HANDLING DEVICES

Irving Gabelman, ed. Nov. 1970 368 p refs Presented at the AGARD Avionics Panel Tech. Symp., Istanbul, 1-4 Jun. 1970 (AGARD-CP-67) Avail: NTIS

Papers are presented on the design and development of equipment for data storage, recording, processing, display, and communications systems.

N71-13836# Sperry Gyroscope Co., Ltd., Bracknell (England).

AN AIRBORNE DATA ACQUISITION SYSTEM INCORPORATING A RECYCLING METAL TAPE FLIGHT DATA RECORDER

A. T. MacDonald In AGARD Data Handling Devices Nov. 1970 24 p

Avail: NTIS

Changes in crash recorder legislation have allowed the introduction of a recycling recorder, in an airborne data acquisition system. The electronic unit accepted a wide variety of analog signals multiplexed and digitized them. The output is a serial pulse code modulated data stream, of 64 words per second for each of 16 bits. The recorder uses 0.5 inch wide 0.0005 inch thick metal tape and operates in a reciprocating mode with a parking density of one thousand bits per inch. Data recovery is accomplished at six times record speed; the output can be analog trace or digital. The method of system integrity checking is described using special purpose test equipment. An appendix derives the dynamic response of the recording process and indicates how playback compensation is used to increase recording density. Author

N71-13840# Forschungsinstitut fuer Funk und Mathematik, Werthoven (West Germany).

DIGITAL RADAR DATA TRANSMISSION

E. Hanle In AGARD Data Handling Devices Nov. 1970 13 p refs

Avail: NTIS

Two radar systems with digital extractors and a data transmission unit to combine the data from both systems in one computer are used for studying tracking problems. For optimum synchronization special information interlaced to the radar information is fed to the modems. These synchronization blocks with the same length as the target blocks have pseudonoise characteristics and are produced in a feedback shift register, which also serves for the time control of the whole data transmission process. It is shown, that simple parity information added to every block in combination with the synchronization blocks gives enough security against errors in transmission of radar information. Author

N71-13913# Compagnie Generale de Telegraphie sans Fil, Paris (France).

OPTIMIZATION BY COMPUTER OF AIRPORT RADOMES [OPTIMISATION SUR ORDINATEUR DES RADOMES AEROPORTES]

R. Pierrot / In AGARD Advanced Radar Systems Nov. 1970 9 p
ref In FRENCH

Avail: NTIS

The described computer program calculates antenna beam projection from radomes. Evaluations of axial deviation, transmission fading and remounting of secondary sidelobes are used to obtain optimal parametric combinations for considered problems (general radome form, permissible wall thickness), the theoretic radio electrical performance, and the importance of perturbation effects on radome realization and of temperature variations during flight.

Transl. by G.G.

N71-13926# Plessey Radar, Ltd., Cowes (England).

THE PLESSEY DIGITAL MTI SYSTEM

P. Bradsell / In AGARD Advanced Radar Systems Nov. 1970 10 p

Avail: NTIS

The Plessey Digital moving target system was designed from the start as part of an air traffic control radar system. The cabinet contains the coherent receivers and digitizer, the canceller frame, the digivideo (signal processing) frame and all clock and timing circuits. It takes in interference signals and lock pulse and normal video from the transmitter receivers and gives out video to the displays. The transmitter is triggered from the moving target indicator rack either at internally generated pulse rate frequency or in synchronism with an external lock pulse. The system was completely developed in one year and is now in production.

Author

N71-13935# Forschungsinstitut fuer Funk und Mathematik, Werthoven (West Germany).

SOME STATISTICAL RESULTS COMPARING DIFFERENT TRACKING LOGICS

W. A. Both and H. Fleckner / In AGARD Advanced Radar Systems Nov. 1970 15 p refs

Avail: NTIS

The idea of a radar-digital extractor-computer controlled air space resulted until now in a variety of track operators, which all have the common objective to approximate the real air traffic situation by an adequate track net. In the sequel two sensible functions are given which in a certain sense measure the quality of a track-operator's approximation of a real net. Furthermore, some knowledge about real- and false track processes concerning a special track operator is gained. As an example the functions are applied to some track operators based on primary radar information.

Author

N71-13936# Aeg-Telefunken, Ulm (West Germany).

DIGITAL RADAR PLOT EXTRACTOR: A SYSTEM MODULE OF AN AUTOMATIC AIR TRAFFIC CONTROL SYSTEM

H. Ebert and U. Siegenthaler / In AGARD Advanced Radar Systems Nov. 1970 17 p

Avail: NTIS

Described are the computer system's functions in target tracking and presentation of processed data. Tracking, i.e. automatic recognition of aircraft movements, is done in a first digital computer based on the transmitted information of several radar installations whose coverage areas overlap (multiradar tracking). A second computer is used for processing the information that is presented at the individual controller displays. The radar plot extractor consists of two parts, the plot detector and the plot processing unit. The plot detector is a system specifically designed for automatic target recognition and determination of target coordinates. For further processing of target information again a digital computer is used.

Author

N71-13938# Electronique Marcel Dassault, St. Cloud (France).
HELICOPTER RADAR FOR OBSTACLE AVOIDANCE [RADAR D'EVITEMENT D'OBSTACLES POUR HELICOPTERE]

Gerard Collot / In AGARD Advanced Radar Systems Nov. 1970 16 p In FRENCH

Avail: NTIS

The described radar is mounted on the helicopter nose and its operation permits helicopter flight during all seasons at very low altitudes. The equipment consist mainly of the radar unit that scans during overflight the surrounding space and an indicator installed in the cockpit on whose surface images all obstacles. The radar adapts particular well to helicopter flight conditions and its reflections make it possible to avoid vertical as well as horizontal obstacles. Obtained flight test results employing natural as well as artificial obstacles, such as towers and high power cables, confirmed theoretical evaluations.

Transl. by G.G.

N71-13939# Ministry of Defence, London (England).

A COST EFFECTIVENESS STUDY OF THE AIRBORNE EARLY WARNING AIRCRAFT AS AN INTEGRATED PART OF AIR DEFENCE SYSTEMS

T. H. Kerr / In AGARD Advanced Radar Systems Nov. 1970 13 p

Avail: NTIS

Advances in radar technology now make it possible to detect low flying targets against the ground clutter. Using this type of radar (pulse Doppler) installed in Airborne Early Warning (AEW) aircraft as part of a mix with fighters and Surface-to-Air Missile (SAM) systems, it is possible to obtain an all-altitude defence in depth and, in particular, considerably improve the effectiveness of the defences against attack by low flying aircraft. The effectiveness of a constant cost mix of fighters with AEW as compared with that of fighters alone and the improvement in effectiveness is shown. In addition, the variation of overall effectiveness of the defences of a task force with AEW radar range is examined. Using a mathematical model to simulate the operation of AEW aircraft and radar systems, the number of aircraft required to man one station is presented as a function of the aircraft and radar size, power etc. and the probability of being on patrol.

Author

N71-13958* National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

POSITION LOCATION SYSTEM AND METHOD Patent

Charles R. Laughlin and Roger C. Hollenbaugh, inventors (to NASA) Issued 10 Feb. 1970 (Filed 30 Jan. 1968) 22 p Cl. 343-112; Int. Cl. G01s5/12

(NASA-Case-GSC-10087-2; US-Patent-3,495,260;

US-Patent:Appl-SN-701744) Avail: US Patent Office CSCL 17G

A system for determining the position of moving objects, deriving centralized air traffic control data, and communicating via voice and digital signals is examined. The system operates between remote aircraft supersonic transports, and central and peripheral ground stations through a synchronous satellite relay station. Drawings illustrate examples for working the relay system. E.H.W.

N71-14019*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.

PERFORMANCE OF A 10 DEG CONICAL PLUG NOZZLE WITH VARIOUS PRIMARY FLAP AND NACELLE CONFIGURATIONS AT MACH NUMBERS FROM 0 TO 1.97

Douglas E. Harrington Washington Dec. 1970 49 p refs

(NASA-TM-X-2086; E-5698) Avail: NTIS CSCL 21H

A plug nozzle with a ratio of throat area to nacelle area of 0.23 was tested with full-length plug and several truncated

plugs and at several secondary flow ratios. Internal expansion was varied by translation of a cylindrical secondary shroud. A nozzle gross thrust coefficient of 1.02 was obtained at Mach 1.97 at a supersonic cruise pressure ratio of 2.7 with a secondary weight-flow ratio of 4 percent. At subsonic cruise, nozzle gross thrust coefficient was sensitive to the design of the nacelle and primary nozzle flap.

Author

N71-14045* AiResearch Mfg. Co., Los Angeles, Calif.
HYPERSONIC RESEARCH ENGINE PROJECT, PHASE 2. CATEGORY 1 TEST REPORT ON STRUT THERMAL PERFORMANCE AND THERMAL CYCLE TESTING

R. C. Chansler, ed. 3 Oct. 1969 107 p refs

(Contract NAS1-6666)

(NASA-CR-111812; AP-69-5547) Avail: NTIS CSCL 21E

Outlined are the procedures and results of tests conducted on full-scale struts of the Hypersonic Research Engine (HRE). The tests were designed to determine: (1) thermal performance and thermal fatigue resistance of the strut; (2) thermal performance and thermal fatigue resistance of the support panels which simulate the engine structural shells in the vicinity of the struts; and (3) coolant flow distribution.

Author

N71-14055* Techtran Corp., Glen Burnie, Md.

KINEMATICS OF INERTIAL NAVIGATION SYSTEMS

M. I. Zakharin et al Washington NASA Dec. 1970 236 p refs Transl. into ENGLISH of the book 'Kinematika Inertsialnykh Sistem Navigatsii' Moscow, Mashinost., 1968 p 1-234

(Contract NASw-1695)

(NASA-TT-F-614) Avail: NTIS CSCL 17G

In the problem of automatic flight control, an important place is occupied by the determination of the instantaneous values of the kinematic parameters of the motion of an aircraft with respect to a chosen system of calculation. In order to solve this problem navigational systems may be employed in which operation is based on various physical principles. Methods are examined for determining the instantaneous values of the parameters of aircraft by means of inertial navigation systems, based on the independent measurements of absolute acceleration of movement with subsequent consideration for the gravitational field in which the flight is being accomplished.

Author

N71-14056* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

THEORETICAL AND EXPERIMENTAL VIBRATION AND BUCKLING RESULTS FOR BLUNT TRUNCATED CONICAL SHELLS WITH RING-SUPPORTED EDGES

Sidney C. Dixon, Robert Miserentino, and M. Latrelle Hudson Washington Dec. 1970 33 p refs

(NASA-TN-D-7003; L-7061) Avail: NTIS CSCL 13M

Theoretical results indicate that rings designed to provide edge restraint between simple and clamped support on the basis of buckling calculations do not provide the equivalent support on the basis of vibration calculations for modes having few circumferential waves. The natural frequencies for these modes were considerably below the minimum frequencies for shells with simply supported or clamped edges. For such cases, studies indicate that substantial increases in ring size and mass are required to effect a significant increase in the minimum frequency of ring-supported shells. Experimental buckling and vibration results were obtained for four blunt truncated conical shells essentially clamped at the small end and ring supported at the large end. Buckling was induced by aerodynamic loading in wind tunnel tests. Theoretical results for the same shells are in good qualitative agreement with the experimental results, but the quantitative agreement is only fair.

Author

N71-14073* Boeing Scientific Research Labs., Seattle, Wash. Flight Sciences Lab.

A SEQUENCE OF TRANSIENT ACOUSTICAL SOURCES IN AN IDEALIZED JET

E. W. Graham Sep. 1970 21 p refs

(DI-82-1002) Avail: NTIS

A sequence of transient acoustical point sources is considered as a noise generator in an idealized two-dimensional jet. Each transient source starts at the same position relative to the stationary nozzle (or external air), drifts downstream with the local fluid for a given time, then disappears. As each source disappears a new one appears at the initial position. The far field mean-square pressures are obtained from a previous analysis of the effects of permanent sources, and are converted from a coordinate system fixed in the source to retarded coordinates fixed in the external air (or stationary nozzle). In the examples, two jet velocity profiles are studied, first a jet composed of linear velocity profile shear layers meeting at the center, and second a uniform jet bounded by velocity discontinuities. As found previously for the permanent source, large differences in far field mean-square pressures appear for these two jet velocity profiles. However, the greatest magnitudes of mean-square pressure are now rotated into the downstream field.

Author

N71-14086* Aeronautical Research Associates of Princeton, Inc., N.J.

A STUDY OF PANEL FLUTTER WITH THE EXACT METHOD OF ZEYDEL

J. E. Yates Washington NASA Dec. 1970 98 p refs

(Contract NAS8-24390)

(NASA-CR-1721; ARAP-145) Avail: NTIS CSCL 13M

The exact method of Zeydel for calculating flutter boundaries and estimating stresses in an infinite spanwise array of panels is presented. The theory is based on the exact linearized inviscid aerodynamic theory. A general analysis of orthotropic panels is presented that accounts for different edge conditions, elastic foundation, membrane stresses, and viscous and structural damping. Various asymptotic results are presented for very long panels. Two limits of the exact theory are discussed that correspond to the simple static aerodynamic theory approximation and the traveling-wave theory, respectively. A further result for the mode shape of a semi-infinite panel is presented that shows how a traveling wave is amplified and reflected by the trailing edge. Extensive numerical calculations are presented for the special case of pinned edge panels, isotropic panel material, zero viscous damping, and no elastic foundation. Comparisons are made with previous results that verify the computational procedure. Design flutter boundaries of mass ratio versus length-to-width ratio for different materials and altitude are presented. Typical mode shapes are also given. The effect of structural damping at different Mach numbers and length-to-width ratios is discussed. Example calculations of the stress level in a panel are made. Design flutter boundaries are presented for aluminum panels on a typical Saturn 5 trajectory. Flutter is indicated for certain panels on the forward skirt of the S-4B stage, in agreement with in-flight data. Because of the relatively short duration of flutter, it is concluded that failure is not likely to occur.

Author

N71-14087* National Physical Lab., Teddington (England). Aerodynamics Div.

AN EXPERIMENTAL STUDY OF A FAST, MECHANICALLY OPERATED MODEL INJECTION SYSTEM

M. J. Larcombe, K. A. Dolman, and P. A. Taylor 16 Sep. 1969 15 p refs

(NPL-AERO-1300) Copyright. Avail: NTIS

A description is given of a fast, mechanically operated, model-injection system for heat-transfer measurements using the

thin-wall technique. The system is designed to produce a controlled acceleration profile in order to minimize oscillations of the model following the injection. Results obtained show that the model oscillations have decayed to an acceptable level after 0.07 seconds from the initiation of injection.

Author

N71-14138* National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

ABLATION PERFORMANCE OF GLASSLIKE CARBONS, PYROLYTIC GRAPHITE, AND ARTIFICIAL GRAPHITE IN THE STAGNATION PRESSURE RANGE 0.035 TO 15 ATMOSPHERES

Howard G. Maahs Washington Dec. 1970 34 p refs
(NASA-TN-D-7005; L-7290) Avail: NTIS CSCL 11B

The ablation performance of two glasslike carbons, one pyrolytic graphite, and one artificial graphite (ATJ) has been determined in air in five different test environments. The stagnation pressures of these environments ranged from 0.035 atm to 15 atm, and the total enthalpies ranged from 2 MJ/kg to 35 MJ/kg. Surface temperatures ranged from 1600 K to 3450 K. In the higher pressure environments, the mass-loss rates of the glasslike carbons and the pyrolytic graphite were significantly lower than that of the ATJ graphite; however, the pyrolytic graphite tended to delaminate unpredictably. The glasslike carbons tended to develop small pits or craters in their stagnation regions, and wavelike rings, suggestive of surface melting, sometimes formed about their stagnation regions. The observed mass-loss rates of the several materials studied do not agree well with the diffusion-limited rates predicted by commonly accepted graphite ablation models even though, on the basis of surface temperature and stagnation pressure, the ablation rates should be diffusion limited. In addition, the mass-loss rates of the several materials differ considerably from one another. These facts suggest that the mass-loss rate of carbon, is not, at the present test conditions, diffusion limited. Empirical correlations relating mass-loss rate to surface temperature and stagnation pressure were developed for the several materials studied.

Author

N71-14144* Joint Publications Research Service, Washington, D.C.

VIBRATION STABILITY

I. Ananyev et al 10 Dec. 1970 3 p Transl. into ENGLISH from Aviat. i Kosmonaut. (Moscow), no. 11, 1970 p 20-23
(JPRS-51966) Avail: NTIS

Vibrational loads of basic airplane (helicopter) structures in various modes of operation are carefully analyzed for the purposes of protecting the structures from vibrations and ensuring flight safety. Also, the frequency of variable loads are determined, the possible causes of vibrations are established, and measures are taken to eliminate vibrations and to reduce the levels of resulting variable stresses in the structure. In so doing, even low level vibrations are taken into account, since after sufficiently prolonged operation fatigue failure may occur in the structure.

Author

N71-14163* Texas Univ., Austin. Engineering Mechanics Research Lab.

THE EFFECT OF AIRDROP IMPACT ON COMPLEX STRUCTURES Final Report, Aug. 1967 - Dec. 1969

Song Fong Jan and E. A. Ripberger Dec. 1969 50 p refs
(Contract DAAG17-67-C-0189)

(AD-711555; TR-70-55-AD) Avail: NTIS CSCL 15/7

The accelerations and displacements in a complex structure subjected to an impact loading are computed by treating the structure as a lumped parameter system. A mathematical model of the system consists basically of discrete masses linked by weightless, elastic beams with the appropriate stiffnesses, areas, and moment of inertia properties. By specifying a proper set of independent

coordinates through which the motion of these lumped masses are uniquely described, and by writing equations of motion in terms of these coordinates, a set of equations is derived which represents the motion of any part of the model during impact. Using the Runge-Kutta numerical method, and a digital computer, these equations are solved. A physical model of the lumped parameter system was built and cushioned with paper honeycomb. Displacements and accelerations at some points in this model were measured and compared with computed results. Agreement is satisfactory.

Author (TAB)

N71-14171* Virginia Polytechnic Inst., Blacksburg.
MEASUREMENT OF THE GROUND WIND STRUCTURE
Semiannual Status Report

Dec. 1970 31 p

(Grant NGL-47-004-067)

(NASA-CR-115772) Avail: NTIS CSCL 04B

Progress is reported in an aircraft vortex study as a major effect of the ground wind measurement research program. The two part study consists of the following: (1) An experimental vortex investigation was initiated to better understand the basic nature of an aircraft wing-tip vortex. Preparations were made for wind tunnel calibration and evaluation tests on a three dimensional hot-wire anemometer system being developed in the project. (2) A theoretical vortex investigation was begun in an effort to obtain a numerical solution to the Navier-Stokes equations for the trailing vortex as a whole. The proposed method for solution consists of treating the problem essentially as an incompressible boundary layer problem.

D.L.G.

N71-14188* Translation Consultants, Ltd., Arlington, Va.
NEW MATERIALS AND NEW DESIGNS FOR AIRCRAFT
TURBINE ENGINES [NOWE MATERIAŁY I NOWE FORMY
KONSTRUKCYJNE LOTNICZA I ASTRONAUTYCZNA]

J. Czapliski, et al Washington NASA Dec. 1970 15 p refs Transl. into ENGLISH from Tech. Lotnicza i Astronautyczna (Warsaw), v. 25, Jan. 1970 p 13-18

(Contract NASw-2038)

(NASA-TT-F-13398) Avail: NTIS CSCL 21E

Description of new trends in the development of new structural materials, and new concepts in the design of aircraft turbine engines. Special attention is given to the fiber-reinforced materials with metallic or resin matrices, and oxide dispersion hardened alloys. New design concepts involving the integral structures, fiber-reinforced composites and honeycomb structures are described.

Author

N71-14199* Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

RAMJET TECHNOLOGY. CHAPTER 11: HYPERSONIC RAMJETS

G. L. Dugger and F. S. Billig Mar. 1970 148 p refs

(Contract N0w-63-0604-c)

(PB-193911; APL-TG-610-11) Avail: NTIS CSCL 21E

The special problems associated with ramjets flying at hypersonic speeds are addressed, and the potentialities of ramjets using subsonic and supersonic ducted burning and external burning for the hypersonic flight regime are discussed and compared. Included are: theoretical approaches for treating boundary-layer, non-uniform-flow, and non-equilibrium effects; inlet efficiency parameters; leading edge problems (ablation, forced cooling, and drag considerations); performance of hypersonic inlets; theoretical analysis and experimental results on external burning for drag reduction and side-force production; theoretical descriptions of supersonic heat addition and a few experimental results; summaries of hypersonic airplane studies based on subsonic burning ramjets and turboramjets; and theoretical overall performance of supersonic combustion ramjet engines.

Author (USGRDR)

N71-14307*# National Aeronautics and Space Administration, Washington, D.C.

ACOUSTICS TECHNOLOGY A Survey

Skipwith W. Athey 1970 138 p refs

(NASA-SP-5093) Avail: SOD \$0.65; NTIS CSCL 20A

This survey reflects the continuing contributions of NASA in the problems of sound and acoustics, particularly those involving noise reduction. As an atmospheric pollutant, the effects and damages of noise are treated from structural damage to aircraft and spacecraft to the physical and psychological disturbance and annoyance incident to the noise generated. Special technical contributions include determining what mechanism generates the noise from high-speed gas jets, and the study of noise propagated by spacecraft boosters in the atmosphere. Predicting the conditions under which anomalous propagation will occur will permit launching or tests to be scheduled when the atmospheric conditions are favorable. Another area of concentration is investigating the origin of the compressor noise generated in a turbojet aircraft engine. The greatest long-range nonaerospace value, however, has been determining and evaluating the actual subjective effects of noise on human beings. The development of a more valid measurement of the subjective effects of noise has proved the most useful tool in this direction. E.M.C.

N71-14363*# Pratt and Whitney Aircraft, East Hartford, Conn.
**SINGLE-STAGE EVALUATION OF HIGHLY-LOADED
HIGH-MACH-NUMBER COMPRESSOR STAGES. 3: DATA
AND PERFORMANCE TANDEM ROTOR**

G. D. Burger and M. J. Keenan Jan. 1971 193 p refs

(Contract NAS3-10482)

(NASA-CR-72772; PWA-3954) Avail: NTIS CSCL 21E

A single-stage compressor with a 0.5 hub/tip ratio tandem rotor was designed to produce a pressure ratio of 1.936 at an efficiency of 84.2 percent. Rotor-tip speed was 1600 fps and flow rate was 187.1 lbs/sec. The design pressure ratio was obtained at design speed, with an efficiency of 83.1 percent and a flow of 177.8 lbs/sec. With radial inlet distortion, peak stage efficiency at design speed was 177.8 percent at a pressure ratio of 1.821 and a flow of 174.0 lbs/sec. With circumferentially distorted inlet flow, the peak stage efficiency was 74.4 percent at a flow of 165.7 lbs/sec and a pressure ratio of 1.766. Author

N71-14410# Commissariat a l'Energie Atomique; Saclay (France). Centre d'Etudes Nucleaires.

**EXPERIMENTAL STUDY OF A GAS FLOW NEAR A FLAT
SURFACE FITTED WITH FINS INCLINED WITH RESPECT
TO THE DIRECTION OF GAS FLOW [ETUDE
EXPERIMENTALE D'UN ECOULEMENT DE GAZ VOISINAGE
D'UNE PAROIS PLANE MUNIE D'AILETTES INCLINEES
PAR RAPPORT A LA DIRECTION DE L'ECOULEMENT]**

Nicole Juignet Aug. 1970 108 p refs In FRENCH

(CEA-N-1329) Avail: AEC Depository Libraries

In nuclear gas-graphite power reactors, the heat exchange between fuel elements and cooling gas was improved by use of cylindrical cans fitted with cooling fins in a herring-bone pattern. An experimental study was made of the gas flow by analyzing the distribution of velocity vectors between the fins and the main gas flow; this was done on a full-scale model of a section of the can. These aerodynamic study and heat transfer tests showed the origins of the thermal anomalies observed on these surfaces and their distribution law along a set of cartridges. A study was also made of the influence of the size of the slot between the can sectors and of the channel diameter on both the thermal anomalies and on the average exchange coefficient level. Author (NSA)

N71-14430*# American Airlines, Inc., New York.

AIR TRANSPORTATION

Richard F. Lambert In NASA. Electron. Res. Center Future Fields of Control Appl. Aug. 1969 p 39-53

Avail: NTIS

Control problems in airline operations are identified, with emphasis on airfreight handling, and examples of solutions to these problems are mentioned. Problem areas covered include: navigation systems, airport construction, smoke and noise reduction, jumbo size jet passenger traffic and cargo handling, and applications of computers in maintenance operations. E.C.

N71-14494# East Central Florida Regional Planning Council, Titusville.

GENERAL AVIATION AIRPORT SYSTEM

Feb. 1970 78 p refs Prepared by Orange-Seminole-Osceola Planning Comm. for East Central Fla. Regional Planning Council (PB-191239) Avail: NTIS CSCL 05A

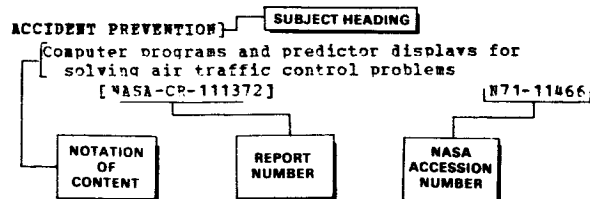
An inventory of existing airports in Orange, Seminole, and Osceola is presented. Data on aviation activity trends, land use patterns, highway access, aircraft owners, finance, organization and tourism are shown. Standards for general aviation airport planning are developed and used for system analysis and evaluation. Recommendations are presented concerning a plan for general aviation airports, staged construction, organization and finance, and proposed land use near three airports. Author (USGRDR)

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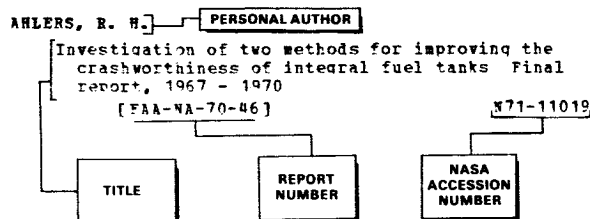
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